

APPENDIX E CONSTRUCTION STANDARDS*

***Editor's note:** Ord. No. 82-75, § 1, adopted Nov. 16, 1982, adopted construction standards for the City of Grapevine, which have been included herein as App. E, at the discretion of the editor. The language of the ordinance remains as originally enacted with the exception of words that may appear in brackets which were added by the editor for clarity, and contain style changes made for the sake of consistency.

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ARTICLE I. STANDARDS OF DESIGN

Item 1. General Requirements.

1.1. Introduction:

This manual, "Standards of Design," is to implement the provisions of the subdivision ordinance and to provide for the orderly, safe, healthy and uniform development of the area within the corporate city limits and within the area surrounding the city.

The Specifications for Construction [Articles II and III of this appendix] and the standard details supplement and are made a part of these Standards of Design. These three documents are to be considered as minimum requirements and it shall be the responsibility of the subdivider and his agents to determine if more stringent requirements are necessary. The adherence to the requirements of these three documents and/or the approval by the city manager and his agents of submittal data in no way relieves the subdivider of the responsibility for adequacy of design, completeness of plans and specifications or the suitability of the complete facilities.

The subdivider shall notify the city engineer, in writing, of any deviations from the requirements set forth in the Standards of Design, Specifications for Construction or Standard Details. Such deviations must be approved in writing by the city engineer prior to beginning of construction.

1.2. *Standards of design:* The Standards of Design, as adopted by the City of Grapevine, are set forth herein. These standards shall be considered as a minimum requirement and it shall be the responsibility of the subdivider to determine if more stringent requirements are required for his particular development. It is not intended that the Standards of Design cover all aspects of a subdivision. For those elements omitted, the subdivider will be expected to provide designs and facilities in accordance with good engineering practice and to cause to be constructed facilities utilizing first class workmanship and materials. It is expected that the Standards of Design will be amended at intervals; therefore, developers and their engineers shall verify the standards for latest revision.

1.3. *Standard details:* In an effort to have uniformity and to facilitate maintenance, the city has adopted standard design features for certain facilities such as manholes, street sections, curb inlets, ramps for the handicapped, etc. These requirements are shown as standard details, which are included in the documents. The standard details are included in the standards for reference and use by engineers and planners. Any variations from the standards shall have written approval by the city.

1.4. *Specifications for construction:* Specifications for Construction as adopted by the City of Grapevine are bound as two separate documents: (1) Specifications for Construction--Water Distribution and Sewer Line Construction [Article III of this appendix], and (2) Specifications for Construction--Streets and Drainage [Article II of this appendix]. These specifications should be considered as minimum requirements and such additional requirements as the subdivider may consider appropriate should be added as supplements.

1.5. *Inspection of construction by city personnel:* All construction and verification of compliance to the plans and specifications shall be conducted by the city inspection staff under the direction of the city engineer. The facilities included in this inspection requirement include but are not limited to:

Public Facilities

streets

traffic signals
driveways
storm drainage systems
water distribution systems, and
sanitary sewer collection systems

all constructed in public street rights of way or public easements and dedicated to the city as public facilities as well as:

Private Facilities

private roadways
parking lots
driveways
traffic signals
storm drainage systems
water distribution systems, and
sanitary sewer collection systems

all constructed on private property as private systems but requiring thorough review and inspection by the city due to the private systems potential detrimental impacts upon the city's public systems if designed and constructed improperly.

The subdivider shall advise all of the construction contractors of this requirement. No subdivision will be accepted by the city until and unless all construction that falls under these two categories has been approved by the city inspection staff.

1.5.1. *Design review and inspection fees.* The subdivider shall be charged a design review and inspection fee for the public and private facilities listed in section 1.5 in an amount equal to 5 percent of the construction costs of the facilities in each subdivision. A re-review fee of \$250.00 shall be imposed upon all submittals of construction plans after the first two submittals have been reviewed and comments have been issued by staff.

Prior to acceptance of the subdivision and approval of construction by the city, the subdivider shall file copies of the executed construction contracts with the director of public works, for a determination of the actual amount of the fee to be assessed against the subdivider, and the subdivider shall execute and file a confirmation of donated assets statement for the public facilities in the form approved by City Resolution No. 89-05, as the same may be amended from time to time.

The individual building or swimming pool permit applicant shall be charged a drainage inspection fee for: (1) The review of lot to lot drainage plans submitted at time of building or swimming pool permit application; (2) The comparison of the proposed lot grading and drainage plan with the lot grading and drainage plan included in the construction plans of the subdivision; and (3) Final inspection of the lot grading at the time of

completion of the building or swimming pool and application for final approval to insure that the drainage is collected and conveyed within the guidelines of the lot to lot drainage program and policies of the city.

A fee of \$500.00 shall be imposed for processing floodplain reclamation applications and letters of map revision (LOMR's) for FEMA designated streams.

Drainage inspection fees shall be imposed for each individual building or swimming pool permit application as follows:

TABLE INSET:

Single family and duplex	\$ 150.00
Swimming pools	\$ 150.00
All remaining classifications of development full acre cost	\$ 350.00 per acre
Portion other than full acre	\$ 350.00 X percentage of full acre

1.5.2. *Inspection overtime reimbursement:* The contractor may undertake work during working hours established in section 12-87, Noise--Character, intensity, and duration detrimental to health or life, of the City Code of Ordinances, as amended. Any work prior to 8:00 a.m. or after 5:00 p.m. on Monday through Friday and between 7:00 a.m. and 7:00 p.m. on Saturday, Sunday and holidays may only be undertaken if the contractor signs the necessary forms committing to reimburse the City of Grapevine for overtime costs of \$45.00 per hour due to the inspection activities required by the work underway with a guaranteed minimum of four hours overtime on Saturdays, Sundays and holidays to justify the inspection activities on these days. By signing the forms, the contractor commits to reimburse the city on a monthly basis upon receipt of a monthly invoice from the city.

1.6 *Utilities to be underground.*

A. *Definitions.*

Utility. A company providing electrical, telephone, cable TV, and fiber optic services within the City of Grapevine under a franchise agreement with the City of Grapevine.

Transmission lines. Those electrical lines operated at nominal voltages of 60,000 volts or higher.

Feeder lines. Those electrical lines that emanate from substations to distribute power throughout an area.

Lateral lines. Those electrical lines that emanate from an electric feeder line and are used to distribute power to smaller areas of electric consumers and service lines.

Service lines. Those electrical lines which through a transformer connect a lateral line to a customer's service entrance.

B. Attached hereto as Exhibit "A", and made a part hereof for illustrative purposes only, is a diagram depicting electrical distribution equipment. (Exhibit "A" is not included herein but is on file and available for

inspection in the office of the city clerk)

- C. Subject to the requirements and conditions of this ordinance, new electric lateral lines and service lines shall be placed underground, throughout new subdivisions for which final plats or site plans are approved subsequent to the effective date of this ordinance, except when such lateral lines or service lines are emplaced or installed in connection with a utility's replacement, supplementation, or upgrade of an existing aerial utility system.
- D. Electric transmission and feeder lines may, at the discretion of the responsible utility company, be placed above ground.
- E. In case of special or unique circumstances, or to avoid undue hardship, the city council of the city may authorize variances or exceptions to the requirements of Item 1.6(C).
- F. Where, in accordance with this ordinance, electric utility service lines are required to be placed underground, telephone service, cable TV, fiber optic and street lighting shall also be placed underground, except for light standards.
- G. Where electric lateral lines and service lines are approved to be placed above ground, telephone service, cable TV, fiber optic and street lighting may also be placed above ground if attached to existing electric poles.
- H. All electric, telephone, fiber optic, and cable TV support equipment (transformers, amplifiers, switching devices, etc.) necessary for underground installations shall be pad mounted or placed underground, and the difference in the cost of providing or installing such facilities, resulting from their installation underground, shall be paid to the installing utility company in accordance with the requirements of Item 1.6(I) hereinbelow.
- I. A utility company which provides underground utility service, to include, without limitation, installing underground utility lines, shall be reimbursed for and recover the difference in cost, if any, between the installation, operation, maintenance, and anticipated upgrade of such service, and the installation, operation, maintenance, and anticipated upgrade of comparable or equivalent overhead service. The amount to be recovered shall be based on the utility company's reasonable estimate of such difference in cost, and shall be paid to the utility company, by the utility customer receiving such service, at such time as the underground utility service is first provided. Utility companies shall be responsible for developing administrative policies and cost reimbursement procedures to allow for the recovery of such differences in cost. No utility company shall be required to begin construction of underground facilities unless and until the owner or developer of the property has made arrangements satisfactory to the specific utility company for the payment of such difference between the cost of overhead facilities and underground facilities.
- J. Temporary service during construction may be provided by overhead utility lines and facilities prior to final release of the underground service.

Following final release of the underground permanent service, the temporary overhead service shall be removed within 45 days.

- K. The electric utility company may plan and construct overhead electric feeder lines on perimeters of subdivisions or property without obtaining a variance. Telephone, cable television, and fiber optic lines may be constructed overhead where overhead electric utility lines are permitted.
- L. Nothing contained herein shall be construed to require any existing overhead facilities to be placed underground or to prohibit the upgrading, reconstruction or reconductoring of any existing overhead facilities with overhead construction.

1.7. *Building permits:* The issuance of building permits will be withheld by the city until the utilities, streets and storm drains are complete and accepted by the city. All pro rata water and sewer fees shall be paid prior to acceptance by the city.

1.8. *Temporary toilet facilities at construction sites.* The owner or his agent may be required by the director of public works, in said official's discretion where the conditions warrant such requirement, to provide temporary toilets for use by workmen during the construction of a subdivision. The toilets shall be connected to the sewer system or use an approved chemical type portable facility. The temporary toilets shall be maintained in a sanitary condition.

(Ord. No. 84-71, § 1, 9-18-84; Ord. No. 85-63, § 1, 10-1-85; Ord. No. 89-58, §§ 2, 3, 9-5-89; Ord. No. 90-46, § 2, 8-7-90; Ord. No. 94-76, § 1, 9-20-94; Ord. No. 95-50, § 1, 7-18-95; Ord. No. 96-40, § 1, 6-4-96; Ord. No. 96-67, § 2, 8-20-96; Ord. No. 2002-85, § 5, 11-19-02; Ord. No. 2003-03, § 2, 1-21-03)

Item 2. Street system.

2.1. *General:* The street system, including the street layout, shall be in accordance with generally accepted engineering practices and in compliance with the city plan, the thoroughfare plan, zoning ordinance, subdivision ordinance and other applicable regulations. The drainage system, as incorporated in the street system, shall comply with Item 3 of this manual [article], the plans and specifications, design computations. State planner coordinates shall be assigned to the center line intersections of all streets, at the ends of cul-de-sacs and at all major curves in the streets. These coordinates shall be to "national mapping standards" accuracy and shall be shown on the final construction drawings. The city will furnish coordinates for the closest existing street intersection upon request. Other applicable data shall be submitted to the city for review. Construction shall not commence prior to the approval by the city.

2.2. *Street arrangement.* Unless otherwise approved by the city, provisions shall be made for the extension of existing major thoroughfares, collector streets and those residential streets which may be necessary to provide circulation with adjacent areas. The street arrangements shall conform with the intent of the thoroughfare plan as adopted by the city. Adequate collector streets shall be provided for the circulation of traffic throughout the subdivision. Residential streets shall be provided to accommodate local residential use within the subdivision. Off-center street intersections will not be approved except under unusual circumstances. Curvilinear streets are permissible.

2.3. *Horizontal curve limitations:* The minimum radii at the centerline of the street

shall be in accordance with the following tabulation:

TABLE INSET:

	Minimum radii in feet
Major thoroughfare, Type A & B	2,000
Major thoroughfare, Type C & D	1,125
Collector street	800
Residential street	300

Any deviation from these minimum radii shall be in accordance with "A Policy on Geometric Design of Highways and Streets," 1984, by the American Association of State Highway and Transportation Officials.

2.4. *Block lengths:* In general, streets shall be provided at such intervals as to serve cross traffic adequately and to meet existing streets or customary subdivision practices in the neighborhood. Where no existing plats control, the blocks shall be not more than 1,600 feet in length nor less than 300 feet in length except in unusual cases.

2.5. *Street intersection:* More than two streets intersecting at one point shall be avoided except where it is impractical to secure a proper street system otherwise. Where several streets converge at one point, setback lines, special rounding or cut-off of corners and/or a traffic circle may be required to ensure safety and facility of traffic movement. Thoroughfares and collector streets shall intersect any other thoroughfares and collector streets at an angle of 90 degrees. Minor streets shall intersect thoroughfare and collector streets at 90 degrees. Thoroughfares and collector street intersections shall have property line corner radii with a minimum tangent distance of 30 feet. Residential streets shall have as the property line corner the point of intersection of intersecting streets. Curb radii at intersections shall be not less than 20 feet measured from face of curb. Less than 20 feet may be used only with written approval of the city.

2.6. *Relation to adjoining streets:* The system of streets designated for the subdivision, except in unusual cases, must connect with streets already dedicated in adjacent subdivisions; and where no adjacent connections are platted, must in general be the reasonable projection of streets in the nearest subdivided tracts, and must be continued to the boundaries of the tract subdivided, so that other subdivisions may connect therewith. Reserve strips of land controlling access to or egress from other property or to or from any street or alley or having the effect of restricting or damaging the adjoining property for subdivision purposes or which will not be taxable or accessible for special improvements shall not be permitted in any subdivision unless such reserve strips are conveyed to the city on a fee simple.

2.7 *Dead-end streets, cul-de-sacs and courts:* Courts or cul-de-sacs may be permitted where the form or contour of the land or the shape of the property makes such street design appropriate. Such cul-de-sacs or courts shall provide proper access to all lots and shall not exceed 600 feet in length, measured from the centerline of the intersecting street to the center of the circular end of the cul-de-sac, and the circular end provided shall have a minimum right-of-way radius of 50 feet. Dead-end streets will not be allowed except on a temporary basis pending the development of adjacent property. Where dead-end streets are utilized, a turnaround of the size and dimensions required for a cul-de-sac may be required at the discretion of the director of public works. If drainage is not affected, as determined by the director of public works, curb and gutter may be omitted for the turnaround. A temporary easement must be provided for that portion of the turnaround that lies outside the limits of the normal street right-of-way. The

easement shall provide for termination upon extension of the street and construction of the appropriate curb and gutter sections.

2.8. *Street right-of-way widths:* A minimum right-of-way width for various classifications of streets shall be as set forth in the tabulation below:

TABLE INSET:

Type of Street	Minimum right-of-way in feet
Major thoroughfare, Type A	120
Major thoroughfare, Type B	100
Major thoroughfare, Type C	100
Major thoroughfare, Type D	75
Collector, Type E	70
Collector, Type F	60
Collector, Type G	60
Residential, Type H	50
Residential, Type I	50
Cul-de-sacs	50*

* Residential Street, Type I, shall be used only in connection with cul-de-sacs.

2.9. *Pavement widths:* Minimum widths of pavement for the various classifications of streets shall be as set forth on the drawings on the following pages:

COLLECTOR STREETS

GRAPHIC LINK: collector streets

Collector, Type E Street

(Apartment, commercial and industrial areas)

GRAPHIC LINK: collector, type E street

Two parking lanes of 8' each, two traffic lanes of 11' each (12' preferable for clearance of parked cars)

Collector, Type F Street

(Single-family and duplex residential)

MINOR ARTERIALS

GRAPHIC LINK: minor arterials

Minor Arterial, Type C Street

GRAPHIC LINK: minor arterial, type C street

Minor Arterial, Type D Street

MAJOR ARTERIALS

Three traffic lanes, 11'--12' wide,
no parking plus curb and gutter

GRAPHIC LINK: major arterials

Major Arterial, Type A Street

GRAPHIC LINK: major arterial, type A street

Major Arterial, Type B Street

* The width shown is the minimum. A wider buffer area that moves the sidewalk further away from the arterial is preferred.

GRAPHIC LINK: local streets

2.10. *Alleys and alley widths:* Alleys shall not be allowed in residential areas except by written approval by the city prior to planning. Alleys may be provided in commercial and industrial districts where other definite means cannot be provided for service access such as off-street loading, unloading, and parking consistent with and adequate for the uses intended. Minimum right-of-way widths of alleys shall be 20 feet. Dead-end alleys shall not be permitted, except that the city may waive this requirement where such dead-end alleys are unavoidable and where adequate turnaround facilities have been provided. Adequate provisions shall be made at all intersections in order that equipment can maneuver the corners. The interior edge of pavement, at the corners, shall have a minimum radius of 30 feet. The right-of-way limits shall be expanded, if necessary, beyond the minimum requirement in order to include all of the paved section within the right-of-way of the alley. Alley turnouts shall be paved to the property line and shall be 20 feet wide at that point. All alleys shall have a minimum of 20 feet of concrete paved roadway. The minimum width alley shall only be used if 90-degree parking is not utilized on the alley for access. If 90-degree parking is utilized, the minimum width of paved surface behind the parking shall be 25 feet. Concrete shall have a minimum strength of 3,000 pounds per square inch within 28 days and a minimum cement content of five sacks per cubic yard.

2.11. *Street grades:* Thoroughfare streets may have a maximum grade of five percent, unless the natural topography is such as to require steeper grades, in which case a 7 1/2 percent grade may be used for a maximum continuous distance of 200 feet. Collector streets may have a maximum grade of 7 1/2 percent. Residential streets may have a maximum grade of ten percent, unless otherwise approved by the city where the natural topography is such as to require steeper grades. All streets must have a minimum grade of at least one-half of one (0.5) percent. Centerline grade changes with algebraic difference greater than one percent shall be connected with vertical curves in compliance with the requirements set forth in "A Policy on Geometric Design of Highways and Streets," 1984, American Association of State Highway and Transportation Officials. The design speed shall be in accordance with the tabulation below:

TABLE INSET:

	Miles per hour
Major thoroughfare, Type A & B	55
Major thoroughfare, Type C & D	45
Collector streets	40
Residential streets	30

2.12. *Pavement design:* Pavement design shall be in accordance with good engineering practice. Pavements shall be constructed using either concrete or asphalt. Deviations from design standards included herein shall have written approval of the city engineer. The pavement shall meet requirements of the particular type specified hereinafter.

2.12.1. *Concrete pavement:* Concrete for pavement shall be not less than 3,000 pounds per square inch compressive strength at 28 days with cement content not less than five sacks per cubic yard. The subgrades shall have lime stabilization to a minimum depth of six inches. The lime stabilization shall be used for the full width of the street, back of curb to back of curb plus six inches on each side. Pavement shall be reinforced with No. 3 bars at 24-inch centers to centers in both directions. Minimum concrete thickness of pavement shall be six inches for industrial streets and streets subject to heavy truck traffic. Residential area streets of Types E through I may have concrete thickness of not less than five inches.

2.12.2. *Asphalt pavement:* Asphaltic concrete pavement shall be installed on stabilized subgrade as specified in Standard Specifications for Streets and Drainage for City of Grapevine [Article II of this appendix] unless otherwise approved by the city engineer in writing. Asphaltic concrete shall be installed on subgrade stabilized with either hydrated lime or Portland cement. Minimum thicknesses of stabilized bases shall vary from five inches to seven inches, depending on type of street designation. Details for asphalt pavement are included in Standard Specifications for Streets and Drainage.

2.13. *Curb and gutter:* Curb and gutter shall be required for all streets and avenues. Radial curb and gutter shall be constructed at each corner upon each block to which curb and gutter is constructed. Lay-down corner shall be constructed across all alley intersections. All curb and gutter and all lay-down curbs shall be constructed in accordance with the Standard Details and the Specifications for Construction [Article II of this appendix]. Curb and gutter shall be constructed of concrete having a minimum strength of 3,000 pounds per square inch in 28 days with a minimum of five sacks of cement per cubic yard, ten-foot dummy joints with an expansion joint every 40 feet, no washer aggregate driveway approaches or curb and gutter.

2.14. *Parkways, grades and sidewalks:* All parkways shall be constructed to conform to top of curb grades with a standard transverse slope of one-quarter inch per foot rise from top of curb to back-of-walk line. Where the natural topography is such as to require steeper grades, transverse slopes up to one inch per foot may be used with approval of the city. The back-of-walk line shall be one foot from the property line for all parkways up to and including 14 feet in width, and three feet from the property line for parkways 15 feet and over in width. Parallel residential sidewalks, as may be required and where provided, shall be reinforced concrete not less than four feet in width, parallel

to the alignment of the curb and located wholly within the dedicated street one foot from the property line in parkways up to 14 feet in width and three feet from the property line in parkways 15 feet and over in width. Sidewalks abutting business property shall have a minimum width of six feet. Concrete sidewalks and driveways shall be as specified in Standard Specifications for Streets and Drainage [Article II of this appendix].

2.15 Street posts and markers: The developer shall purchase street sign posts, street name markers and stop signs for each street intersection prior to installation by the city. Costs for the installation of the street sign posts, street name markers and stop signs shall be paid by the developer as follows:

One street sign post, street name marker & stop sign . . . \$150.00

Each additional post & stop sign . . . 75.00

Posts shall be sized and placed to conform to the Texas Manual on Uniform Traffic Control Devices. Installation shall be the responsibility of the city.

2.16. Street lighting: All subdivisions shall be provided with streetlights. In general, lights should be located at street intersections and at intervals no greater than 400 feet apart. Streetlights shall be the equivalent of 175-watt mercury vapor fixtures.

2.17. Curb ramps for handicapped: Curb ramps for the handicapped shall be provided in all commercial areas, industrial areas and in residential areas which have sidewalks. Ramps shall be located to provide adequate and reasonable access for the safe and convenient movement of physically handicapped persons, including those in wheelchairs, across curbs at all pedestrian crosswalks. Ramps shall conform to the standard details or an alternate design subject to the approval of the city.

(Ord. No. 87-76, §§ 1, 2, 11-17-87; Ord. No. 89-41, § 1, 6-20-89; Ord. No. 2002-85, § 6, 11-19-02)

Item 3. Storm drainage system.

3.1 General: Storm drainage facilities shall include all elements of a drainage system consisting of streets, alleys, storm drains, channels, culverts, bridges, swales, and any other facility through which or over which storm water flows; all of which the city must have a right in, either in the form of a dedicated right-of-way or floodway and drainage easements.

Street drainage facilities within new developments shall be designed so that storm water runoff which results from a design storm of 100 years or greater frequency is contained within the available right-of-way and/or drainage easements. The capacity of the street and right-of-way and/or easements and the storm drain pipe acting in combination must be designed for a capacity to safely contain storm water from a design storm of 100-year frequency, without flood damage to nearby occupied structures.

Drainage facilities shall be designed and constructed at such locations and of such size and dimensions to adequately serve the subdivision and the contributing drainage area above the subdivision. The subdivider shall provide all the necessary easements and right-of-way required for drainage structures including storm drains and open or lined channels. Easement widths for storm drain pipe shall not be less than 15 feet and easement widths for lined channels shall be at least 15 feet wider than the top of the channel and unlined channel easements shall be at least 30 feet wider than the top of the channel.

The design flows for the drainage system shall be calculated by the rational method in accordance with standard engineering practice and in accordance with the requirements set forth herein. Curbs, inlets, manholes, etc., shall be in accordance with the standard details. Materials and construction procedures shall conform with the requirements of the standards for construction [Article II of this appendix].

The subdivider shall provide plans and specifications for all drainage structures. Underground drainage pipes shall be used to accommodate flows up to and including the equivalent capacity of a 48-inch pipe. For flows in excess of the capacity of a 48-inch pipe, lined channels may be used in lieu of pipe. Channel bottom shall be concrete and walls as approved by the city. For flows in excess of the capacity of an 84-inch pipe, unlined channels may be used. Unlined or partially lined channels will not be accepted by the city for maintenance purposes unless a 15-foot roadway on both sides of the channel is included and a mixture of rye, (buffalo) and coastal bermuda or other grass requiring minimal amounts of water for growing is established in the easement area. Minimum side slope shall be 3:1.

The design, size, type and location of all storm drainage facilities shall be subject to the approval of the city. The requirements set forth herein are considered a minimum requirement. The subdivider and his engineer shall bear the total responsibility of the adequacy of design. The approval of the facilities by the city in no way relieves the subdivider of this responsibility.

3.2. Storm drainage design criteria:

3.2.1. *General:* For all flood control systems of less than 1,000 acres, the rational method of computing runoff will be used. The method is expressed by the following equation:

$$Q = CIA, \text{ where}$$

TABLE INSET:

Q	=storm flow rate at a given point
C	=coefficient of runoff (the ratio of rainfall to peak runoff)
I	=average intensity of rainfall in inches per hour for a period equal to the time of flow from the farthest point of the drainage area to a point under consideration
A	=area in acres that is tributary to the point of design

Runoff Coefficient C

TABLE INSET:

Type of area or land use	Adopted runoff coefficient C
Parks or open areas	.30
Residential (lots over one acre)	.35
Residential (lots one acre or less)	.50
Townhouses, duplexes	.60
Industrial	.70
Apartments	.75
Business	.80
Mercantile district	.90

Retainage ponds are not acceptable for containment of design flows.

3.2.2. *Time of concentration:*

The time of concentration is defined as the longest time, without unreasonable delay, that will be required for a drop of water to flow from the upper limit of a drainage area to the point of concentration. The time of concentration to any point in a storm drainage system is a combination of the inlet time and the time of flow in the drain. The inlet time is the time for water to flow over the surface of the ground to the storm drain inlet. The shortest inlet time to be allowed for impervious areas on steep slopes shall be five minutes.

Under average conditions the time of concentration to the upstream end of a drainage system shall coincide with the table, Minimum Inlet Time of Concentration.

Under unusual circumstances which will produce times of concentration in excess of those shown in the following table, the time concentration shall be determined through the use of Figure I, Nomograph for Time of Concentration. The nomograph, however, should be used in a judicious manner; otherwise unrealistic times of concentration may result. Some cautions to be exercised in the use of this nomograph are as follows:

- a. The path along which the time of concentration is determined, should be representative of the drainage areas as a whole. On some irregularly shaped drainage areas it is possible to find the time of concentration along a particular path which is representative of only a small portion of the drainage area. This time of concentration may greatly exceed the time concentration which is more representative of the drainage area as a whole.
- b. Overland flow shall be considered channelized at such time as the distance traveled exceeds 200 feet.

Minimum Inlet Time of Concentration

TABLE INSET:

Type of area	Minimum inlet time (in minutes)
Parks and open areas	20
Residential, single-family	15
Residential, multifamily (Townhouses, duplexes, apartments)	10
Industrial	10
Business	10
Mercantile district	5

Since urbanization is anticipated on all drainage areas, all improvements shall be designed for the case of full watershed development.

When the watershed in question is basically undeveloped, the engineer shall attempt to anticipate future fully developed conditions and storm sewer locations and take the resulting velocities into consideration when determining the time of concentration.

- 3.2.3. *Design storm frequencies:* The design storm frequencies shall be in accordance with the tabulation below:

Design Storm Frequencies (Minimum)

TABLE INSET:

Area or facility	Frequency (in years)
Enclosed pipe system	5
Enclosed pipe system and streets and right-of-way	100
Channels and creek improvements (1)	100
Culverts and small bridges	100
Large bridges (2)	100
Drainage easements or floodways between building lines (3)	100
Sump conditions	100

- (1) Channels and creek improvements shall have a one-foot freeboard within the channel.
- (2) Large bridges have total span greater than 50 feet.
- (3) Minimum slab elevation: One-foot freeboard where fences could be constructed to constrict overland flows; the 100-year design storm flows shall be carried underground.

The relationship between rainfall intensity-duration-frequency is set forth in Figure II. These curves have been developed using Technical Paper No. 40, Rainfall Frequency Atlas of the United States, by the U.S. Weather Bureau. These curves shall be used in the design of all storm drain facilities.

3.2.4. Permissible spread of water:

3.2.4.1. *General:* Spread of water refers to the amount of water that may be allowed to collect in streets during a storm of specific design frequency. In order that excess storm water will not connect in streets or thoroughfares during a storm of the design frequency, the following spread of water values shall be used for the various types of streets.

3.2.4.2. Major thoroughfares (divided):

3.2.4.2.1. *Permissible spread of water:* The permissible spread of water in gutters of major divided thoroughfares shall be limited so that one traffic lane on each side remains clear. Gutter flow shall be based on a storm of ten-year design frequency. The flows from a 100-year frequency storm shall be contained within the street right-of-way.

3.2.4.2.2. *Conditions:* Inlets shall preferably be located at street intersections, at low points or grade or where the gutter flow exceeds the permissible spread of water criteria and as directed by the director of public works. Inlets shall be located when possible, on off side streets or alleys when grade permit. The standard gutter depression of five inches shall be used so long as the depression does not fall within a traffic lane. In no cases shall the gutter depression at inlets exceed the standard. In super elevated sections, inlets placed against the center medians shall have no

gutter depression and shall intercept gutter flow at the point of vertical curvatures to prevent flow from crossing the thoroughfare. Unless expressly approved by the director of public works, storm waters will not be allowed to cross major thoroughfares on the surface in valley gutters or otherwise.

3.2.4.3. *Major thoroughfares (not divided):*

3.2.4.3.1. *Permissible spread of water:* The permissible spread of water in gutters of major undivided thoroughfares shall be limited so that two traffic lanes will remain clear during the ten-year design storm. The flows from a 100-year frequency storm shall be contained within the right-of-way.

3.2.4.3.2. *Condition:* Inlets shall preferably be located at street intersections, low points of grades, or where the gutter flow exceeds the permissible spread of water criteria and as directed by the director of public works. Inlets shall be located, when possible, on off side streets, or alleys when grades permit. The standard gutter depression of five inches shall be used so long as the depression does not fall within a traffic lane. In no case shall the gutter depression at inlets exceed the standard. Depressed inlets will be permitted in a standard parking lane. Where inlets are required in traffic lanes, inlets with no depression or recessed inlets shall be used. In super elevated sections, intercept gutter flow at the low point of P.V.C. or P.V.T. to prevent flow from crossing thoroughfare.

3.2.4.4. *Collector streets:*

3.2.4.4.1. *Permissible spread of water:* The permissible spread of water in gutters of collector streets shall be limited so that one standard lane of traffic will remain clear during the ten-year design storm. The flows from a 100-year frequency storm shall be contained within the right-of-way.

3.2.4.4.2. *Conditions:* Inlets shall preferably be located at street intersections, low points of grade or where the gutter flow exceeds the permissible spread of water criteria and as directed by the director of public works. Inlets shall be located, when at all possible, on off side streets or alleys where grade permits. Inlets with the standard gutter depression of five inches shall be used. In no case shall the gutter depression at inlets exceed the standard.

3.2.4.5. *Minor streets (residential):*

3.2.4.5.1. *Permissible spread of water:* The permissible spread of water in gutters for minor streets shall be limited by the height of the curb for standard street sections for a five-year design storm without storm sewer. The flows from a 100-year frequency storm shall be contained within the

right-of-way. The permissible spread of water in gutters for minor streets with split sections shall be limited by the height of the curb for low gutter flow and the depth of flow at the face of the curb corresponding to the crown elevation for high gutter flow.

3.2.4.5.2. *Conditions:* Inlets shall be located at street intersections, low points of grade or where the gutter flow exceeds the permissible spread of water criteria. Inlets with the standard gutter depression of five inches shall be used in all cases unless special grading problems are involved. In no case shall the gutter depression at inlets exceed the standard.

3.2.4.6. *Alleys:*

3.2.4.6.1. *Permissible spread of water:* The permissible spread of water in alleys shall be limited to confining the flow to within the paved area with inverted crowns and be concrete. The flows from a 100-year frequency storm shall be contained within the paved area.

3.2.5. *Flow in storm drains and their appurtenances, velocities and grade:*

3.2.5.1. *Minimum grades:* Storm drains should operate with velocities of flow sufficient to prevent excessive deposits of solid materials; otherwise objectionable clogging may result. The controlling velocity is near the bottom of the conduit and considerably less than the mean velocity of the sewer. Storm drains shall be designed to have a minimum mean velocity flowing full of 2.5 feet per second. The following table indicates the minimum grades for both concrete pipe ($n = 0.013$) and for corrugated metal pipe ($n = 0.024$), flowing at 2.5 feet per second.

Minimum Grades

for Storm Drains

TABLE INSET:

Pipe size (inches)	Concrete pipe slope ft. / ft.
15	.0023
18	.0018
21	.0015
24	.0013
27	.0011
30	.0009
33	.0008
36	.0007
39	.0006
42	.0006
45	.0005
48	.0005
54	.0004
60	.0004
66	.0004

72	.0003
78	.0003
84	.0003
96	.0002

3.2.5.2. *Discharge of storm drain pipe:* Storm drain pipes discharging into lakes shall be set at an elevation such that the top of the pipe shall be below the normal pool level of the lake. Where storm drain pipes discharge in watercourses the invert of the pipe shall be at the same grade as the watercourse. Adequate riprap or the erosion protection shall be provided. All storm drainage pipes in street and alleys shall be installed at a depth sufficient to permit all water lines to pass over them when the water line has a minimum cover of three feet.

3.2.5.3. *Manholes:* Storm drainage manholes shall be located at intervals not to exceed 400 feet for 24 inches in diameter or smaller. In general, manholes should be located at street intersections, storm pipe junctions or changes of grade and changes of alignment. Storm drain manholes for pipes greater than 24 inches in diameter shall be located at points where design indicates entrances into the pipe as desirable. In no case shall the distance between manholes be greater than 800 feet.

3.2.5.4. *Lateral lines:* The minimum size storm drain line from inlet box to the collector lines shall be 18 inches.

3.2.6. *Drainage ditches or channels:* All channels shall have a minimum bottom width of four feet and a depth based on maximum flow. Side slopes of lined channels shall not be steeper than one foot of rise to two feet of horizontal distance; unlined channels shall have a 3:1 slide slope with provision for a 15-foot roadway on both sides of the channel. All channels shall be designed for a minimum of one foot of freeboard at maximum design flow. Channels discharging into watercourses shall have the same invert level as the watercourse.

3.2.7. *General:* In cases when a 100-year storm design utilities the carrying capacity of private property between building lines, the minimum slab elevations shall be established (with one foot freeboard) to prevent flood damage.

3.2.8. *Downstream property owner's permission:* There are three major drainage basins in Grapevine: Denton Creek (Grapevine Lake), Big Bear Creek, and Little Bear Creek. It is the responsibility of the developer of the property in question to obtain the written permission of the downstream property owners between the development and Big Bear Creek or Corps of Engineers property or Little Bear Creek or Denton Creek or the city limit boundary respectively to discharge additional storm water generated by the development. Should the developer of said property not be able to obtain written permission from the downstream property owner, the developer may execute the indemnification statement on record with the public works department in lieu of the downstream property owner's permission requirement.

In addition, the developer of said property can request, in writing, the city to obtain an easement utilizing the city's eminent domain powers. An appropriate contract with the city must be authorized by the city council. The developer will be responsible for all city costs.

When storm drainage discharge crosses the city limit boundary, the downstream city shall be notified and approval may be required. Construction which will increase the runoff shall not begin until after all downstream land owners have approved the discharge and/or the indemnification statement is executed or an easement is obtained.

3.2.9. *Downstream structures:* All downstream drainage structures between the proposed development and Denton Creek, Corps of Engineers property, Big Bear Creek or the city limit boundary shall be reviewed for capacity available. It shall be the developers' responsibility to determine the types, size, grades and capacities of the downstream structures.

3.2.9.1. *Downstream structures; structure improvements:* If no drainage study for a given watershed addressing downstream drainage structures has been prepared or the factors upon which a previous drainage study was based have been substantially changed as determined by the director of public works or his designee, the developer shall, at the developer's sole initial cost and expense, have a drainage study prepared by a registered engineer in the State of Texas to determine: (a) The necessary future capacities of the drainage structures to adequately convey 100-year design flows from the watershed at full development; (b) the existing 100-year flows and runoff coefficients within the watershed prior to the proposed development; (c) the 100-year flows and runoff coefficients generated by each undeveloped tract within the watershed at full development based on current zoning; (d) the existing 100-year flows in excess of existing structures' capacities within the watershed, if any; (e) the total cost of construction to provide downstream drainage structures with adequate capacities for 100-year full development flows within the watershed; and (f) the proportionate share attributable to development of each respective undeveloped tract within the watershed based upon the incremental increase in stormwater runoff from each undeveloped tract at full development compared to the total increase above existing 100-year flows resulting from full development in the watershed. Portions of the watershed which lie outside the city limits of Grapevine shall be analyzed and accommodated as if fully developed.

In the event the drainage study identifies that the existing downstream drainage structures are undersized for existing 100-year flows or inadequate for the sum of the existing 100-year flows and the incremental increase in 100-year flows after the proposed development, the developer required to perform the drainage study shall be required to make improvements to such downstream drainage structure or structures, and/or construct a new downstream drainage structure or structures, which can

adequately convey 100-year design flows from a fully developed watershed. The cost of construction of or improvements to downstream drainage structures to accommodate development outside the city limits shall be distributed on a pro-rata basis to all undeveloped tracts within the watershed inside the City of Grapevine.

The drainage study and all construction plans for the downstream drainage structures shall comply with all ordinances and rules and regulations of the city and shall be approved by the director of public works, or his designee, prior to the commencement of any construction in the development.

The city shall fund through a refund procedure, as funds are available, said availability and source of funds being determined by the city council, that portion of the design cost, construction cost and cost of the drainage study attributable to the existing 100-year flows in excess of existing structures' capacities within the watershed prior to the proposed development. The city's share of the cost shall be based upon the increase in capacity needed for existing structures to contain and discharge existing 100-year flows compared to the difference between the total 100-year flows under fully developed conditions and the existing structures' capacities.

The developer shall fund, at the developer's sole cost and expense and with no reimbursement, that portion of the design cost, construction cost and the cost of the drainage study attributable to the proportionate share of the total increase in 100-year flows caused by the proposed development, including the pro-rata share of 100-year flows generated from future improvements to undeveloped tracts within the watershed which lie outside the city limits of the City of Grapevine, and all engineering, construction and other costs, including drainage studies or portions thereof, related to drainage within the proposed development. The developer shall fund, at developer's sole cost and expense with an expectation of reimbursement from future developers of undeveloped tracts within the watershed, that portion of the design cost, construction cost and cost of the drainage study attributable to the proportionate share of the total increase in 100-year flows caused by other undeveloped tracts at full development of the watershed including the prorata shares of 100-year flows generated from future improvements to undeveloped tracts within the watershed which lie outside the city limits of the City of Grapevine.

Upon completion of the construction of structure upsizing or structure improvements and at the request of the developer funding the construction, the city shall enter into a pro-rata reimbursement agreement, approved by the city council, to enable the developer to be reimbursed for the design cost, construction cost and the drainage study cost in accordance with the provisions

of this paragraph 3.2.9.1. Payment to the developer from future upstream developers shall be by cashiers check or certified check. Developer shall sign an acknowledgement of payment on a form approved by the City of Grapevine as a condition of receipt of payment and developer shall forward a copy of the signed acknowledgement to the director of public works.

The pro-rata reimbursement agreement shall not exceed a term of 20 years and shall provide that the reimbursement requirements for any tract within the watershed shall be paid prior to the approval and acceptance of the construction project by the city for the respective upstream development tract. It is the responsibility of all developers of undeveloped tracts in the city to determine whether a pro-rata payment will be required. In the event the zoning on a tract within the watershed has been changed subsequent to the execution of the pro-rata reimbursement agreement to allow a more intensive use or higher density, the developer of such tract shall be required, solely at his cost with no reimbursement, prior to any construction plans being approved by the city for such tract, to have a new drainage study prepared by a registered engineer to determine the effect of the change in zoning on the downstream drainage structures, and, if deemed necessary by the drainage study, to construct new, or make improvements at his sole cost with no reimbursement to existing, downstream drainage structures to accommodate the increased flows. Any cost incurred by the developer resulting from a zoning change to allow a more intensive use or higher density shall not release said developer from payment of his pro-rata share of costs under any existing pro-rata agreement. In the event the zoning on a tract within the watershed has been changed subsequent to the execution of the pro-rata reimbursement agreement to require a reduction in density or less intensive use, the developer of such tract shall not receive a reduction in the pro-rata share of costs for downstream drainage structure improvement attributable to such tract.

3.3. *Submittals*: Two copies of the following shall be submitted prior to review of construction drawings by city staff.

- (1) Drainage area map showing the entire drainage basin upstream, downstream and including the improvements within the proposed development in accordance with paragraph 3.2.8, and present downstream structures.
- (2) Property ownership map to show property owners in accordance with paragraph 3.2.8.
- (3) Property owners written permission and/or easements acquired by the developer. Any easements which the developer wishes for the city to acquire by eminent domain proceedings shall have the appropriate legal instrument, an appraisal by a certified appraiser, and the appropriate city-developer agreement executed by the developer.

- (4) All calculations shall be submitted and shall include combination street and storm sewer capacities, inlet capacities, intercepted flow calculations with appropriate street capacities, time of concentration calculations, capacities of downstream structures, percentage of ultimate flows and ultimate capacities necessary for fully developed conditions. The effects of the 100-year frequency storm shall be accommodated. Incomplete submittals shall be rejected and a \$500.00 fee assessed for each resubmittal.

(Ord. No. 83-45, § 1, 9-3-85; Ord. No. 90-73, § 2, 12-4-90; Ord. No. 97-05, § 1, 1-21-97)

Item 4. Water system.

4.1. General:

The design and construction of the water distribution system to serve the subdivision shall be in accordance with good engineering principles, these standards of design and the requirements of the Texas State Department of Health. No construction shall commence prior to the approval of the plans and specifications by the city and the Texas State Department of Health.

All facilities shall be of sufficient size to provide adequate capacity for the subdivision. The pipelines shall be sized to meet the maximum instant domestic requirements plus an appropriate allowance for fire protection water. The design criteria shall be submitted to the city with the plans and specifications. The city reserves the right to require oversizing in order to provide capacities for areas outside of the subdivision. Should the city request oversizing, the additional cost will be borne by the city based on the following formula:

TABLE INSET:

City's share of cost	= Cost of facility as constructed less estimated cost of the facility required to serve only the subdivision.
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The minimum pipeline size to serve low density residential areas shall be six inches in diameter and the minimum pipeline size serving apartments commercial, business, industrial, etc., shall be eight inches. In general, all lines shall be looped with no dead ends. Dead-end lines will be allowed only upon approval by the city and shall be furnished with a flush valve arrangement. Industrial areas which may require fire sprinkler systems must be served by a minimum 12-inch water line. Variance to this rule will be based on 1,500 gallons per minute availability during peak demand periods with a minimum residual pressure of 30 pounds per square inch.

4.2. Connections to existing distribution system:

Preliminary discussions concerning take-off points in the distribution system should be conducted with the city engineer or his designated representative prior to finalizing the preliminary designs of the distribution system to serve the subdivision. Connections will be allowed only at locations where the city believes that sufficient quantity and pressures are available to meet the projected requirements of the subdivision. In general, the connections to the existing distribution system shall be made in such a manner to prevent shut-down to a minimum. Unless approved by the city, a tapping valve connection shall be

installed.

In general, the city will not approve a subdivision which cannot be served by extension to the city distribution system.

Under unusual circumstances, the city may consider approval of a private water system which will supply an adequate quantity of potable water to every lot in the subdivision. Such system must meet the approval of the city, the Texas State Department of Health and other appropriate regulatory agencies. In addition, an appropriate agreement between the city and the subdivider must be executed whereby the city may acquire the system at such time as it can be connected into the city-owned and-operated distribution network.

4.3. Location of facilities:

4.3.1. *Pipelines:* Water lines shall be located in the parkways between the back of the curb and the street right-of-way. The location shall be generally 3 1/2 feet from the back of curb on the north side of east-west streets and on the east side of north-south street.

4.3.2. *Gate valves:* In general, gate valves shall be located outside the paved streets and shall be five feet back of curb return to the intersecting street. In general, gate valves shall be located at street intersections (except for fire hydrant leads). Unless otherwise approved, or requested by owner, valves shall be located in the northeast quadrant of the street intersection. All valve boxes shall be encased in concrete pad at the ground surface. Pad shall be 24 inches by 24 inches by four inches. Extensions to existing mains shall start with a gate valve to protect the existing system and extensions to the property line for future extension shall have gate valve near end.

4.3.3. *Fire hydrants:* In general, fire hydrants shall be located at street intersections or near the center of the block. Hydrants should be spaced in such a manner so that all potential building sites are within: (1) a radius of 400 feet, and (2) within 500 feet of hose length without crossing private property between the building line and the back property line. Details are included in the Standard Specifications [Article III of this appendix].

4.3.4. *Flush valves:* Flush valves shall be installed on all dead-end lines and shall comply with the standard details adopted by the city.

4.4. *Service lines:* A water service line shall be laid to each lot with fittings in accordance with the Specifications for Construction (Article III of this appendix) and the standard details. All service lines shall be Type K copper having a minimum size of one inch. At the subdivider's option, a service line may serve two adjacent lots, provided it be a 1 1/2 inch and it is located at the common property line and complies with the standard details. Meter boxes to be furnished by the city shall be set level to the finish lot grades, and an angle meter stop shall be set by the contractor about 12 inches below the meter box top. After the curb and gutter has been installed the water service line shall be marked by inscribing a "W" in the top of the curb opposite the service line location.

4.5. Materials and installation:

4.5.1. *Pipe:* Water pipelines shall be either ductile iron, castiron if approved, asbestos-cement or plastic conforming to the Specifications for

Construction [Article III of this appendix]. Concrete cylinder pressure pipe may be furnished and installed for sizes 16 inches and larger with approval of the city. All pipe shall be installed in embedment material as shown on the standard details and in conformance with the Specifications for Construction.

- 4.5.2. *Gate valves:* All gate valves shall be AWWA Type as manufactured by Mueller, or approved equal, furnished and installed according to the Specifications for Construction [Article III of this appendix].
- 4.5.3. *Fire hydrants:* Fire hydrants shall be Mueller A-423, or approved equal, conforming to the requirements set forth in the Specifications for Construction [Article III of this appendix]. All fire hydrants shall be installed with a six-inch MJX flange gate valve on the hydrant lead. The installation shall be as set forth in the Specifications for Construction [Article III of this appendix].
- 4.5.4. *Service lines:* Service lines shall be in accordance with the designs shown on the standard details. The materials shall be Mueller and shall be installed in accordance with the Specifications for Construction [Article III of this appendix].

4.6. *Testing:*

- 4.6.1. *Hydrostatic test:* All pipelines shall be hydrostatically tested in accordance with the procedures set forth in the Specifications for Construction [Article III of this appendix]. The test shall not be conducted until the total installation is complete including installing service lines, fire hydrants, flush valves, etc. All testing shall be accomplished in the presence of a city representative.
- 4.6.2. *Sterilization:* All facilities shall be sterilized in accordance with the procedure set forth in the Specifications for Construction [Article III of this appendix]. The subdivider will be required to submit samples to an approved laboratory for certification as being free of bacteria. The facilities shall be sterilized and resterilized as may be necessary until such certification can be achieved. The sterilization shall be performed by the contractor in the presence of a city representative. The city representative shall obtain test samples and have sterilization tests performed by a testing laboratory.

(Ord. No. 88-01, § 2, 1-5-88)

Item 5. Sanitary sewer.

5.1. *General:*

The design and construction of the sanitary sewer collection system to serve the subdivision shall be in accordance with good engineering principals, these standards of design and the requirements of the Texas State Department of Health. No construction shall commence prior to the approval of the plans and specifications by the city engineer and the Texas State Department of Health.

All facilities shall be of sufficient size to provide adequate capacity for the subdivision. The sewer lines shall be sized to meet the maximum peak dry

weather flow plus an appropriate allowance for infiltration of storm water. The design criteria shall be submitted to the city with the plans and specifications. The city reserves the right to require oversizing in order to provide capacities for areas outside of the subdivision. Should the city request oversizing, the additional cost will be borne by the city based on the following formula:

TABLE INSET:

City's share of cost	= Cost of facility as constructed less estimated cost of the facility required to serve only the subdivision.
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The minimum sewer line size to serve residential areas shall be six inches in diameter and the minimum sewer line size serving commercial, business, apartments, industrial, etc., shall be eight inches.

5.2. *Connections to existing sewer collection system:*

Preliminary discussion concerning entrance points in the collection system should be conducted with the city engineer or his designated representative prior to finalizing the preliminary designs of the collection system to serve the subdivision. Connections will be allowed only at locations where the city believes that sufficient capacities are available to meet the projected requirements of the subdivision.

In a proposed subdivision where city sewerage facilities are not adjacent to the property but are accessible, the subdivider shall provide, at his expense, an approach outfall main of sufficient size to serve his subdivision. If the city determines that a larger size is required for future extensions, the city shall pay the additional cost of oversizing based on the formula set forth in Paragraph 5.1.

In general, the city will not approve a subdivision which cannot be served by extensions to the city sewer collection system. Under unusual circumstances, the city may consider approval of a private sewage system which will provide an adequate collection and treatment facilities to serve every lot in the subdivision. Such system must meet the approval of the city, the Texas State Department of Health, the Tarrant County Health Department and other appropriate regulatory agencies. In addition an appropriate agreement between the city and the subdivider must be executed whereby the city may acquire the system at such time as it can be connected into the city-owned and-operated sanitary sewerage facilities.

5.3. *Location of facilities:*

5.3.1. *Sewer lines:* Sewer lines shall generally be located in the street halfway between the street center line and the curb on the south side of east-west streets and on the west side of north-south streets. The standard details shall show proper locations as approved by the city engineer.

5.3.2. *Sewer service lines:* Sewer service lines shall be laid to each lot. The service lines shall be plastic pipe having a minimum diameter of four inches and shall extend to the property line. Sewer service lines shall be located on the lower side of each lot and as approved on the final construction plans by the city. In general, only one lot shall be served by a service line. Under unusual circumstances whereby a single service line can serve two lots, if approved by the city, the minimum diameter shall be

six inches. After the curb and gutter has been installed, the sewer service line location shall be marked by inscribing an "S" in the top of the curb at the service line location.

- 5.3.3. *Manholes*: In general, manholes shall be located at all intersections of sewer lines, changes in grade, changes in alignment and at distances not to exceed 500 feet.

5.4. *Materials and installation*:

- 5.4.1. *Pipe*: Pipe used for sewage collection systems shall be PVC plastic pipe or vitrified clay conforming to the Specifications for Construction. All pipe shall be installed in embedment material as shown on the Standard Details and in conformance with the Specifications for Construction [Article III of this appendix].

- 5.4.2. *Manholes*: Manholes shall be precast concrete or cast-in-place concrete and conforming to the standard details and the Specifications for Construction [Article III of this appendix].

- 5.4.3. *Cleanouts*: In general, manholes may be installed at the upper end of all sewer collector mains. Cleanouts may be installed in lieu of manholes at these locations subject to the approval of the city engineer. Cleanouts shall conform to the standard details and the Specifications for Construction [Article III of this appendix].

5.5. *Testing*: All sewer lines shall be tested for infiltration in accordance with the procedures set forth in the Specifications for Construction [Article III of this appendix]. All testing shall be accomplished in the presence of a city representative.

Item 6. Design standard drawings.

6.1. *General*: At intervals the city shall adopt detail drawings that planners are to use for construction details. Planners, or engineers, that propose structures within the jurisdictional area, including the city limits, shall inquire for information regarding such standards before preparing details for construction.

6.2. *Availability of city standards*: Planners and engineers may obtain copies of city standards (drawings) at the same cost for obtaining same from reproduction firms.

GRAPHIC LINK: city standards drawings (1)

GRAPHIC LINK: city standards drawings (2)

ARTICLE II. STANDARD SPECIFICATIONS FOR CONSTRUCTION-- STREETS AND DRAINAGE

Item 1. General requirements.

1.1. *Materials*:

These specifications are intended to be so written that only materials of the best quality and grade will be furnished. The fact that the specifications may fail to be

sufficiently complete in some detail will not relieve the contractor of full responsibility for providing materials of high quality and protecting them adequately until incorporation in the project. The specifications for materials set out the minimum standard of quality which the owner believes necessary to procure a satisfactory project. No substitutions will be permitted until the contractor has received written permission of the city to make a substitution for the material which has been specified.

Where the term "or approved equal" is used, it is understood that if a material, product or piece of equipment of the specified name and quality is furnished it will be approved, as the particular trade name and quality was used for the purpose of establishing a standard of quality acceptable to the owner. If a product of any other name is proposed for use, the city engineer's written approval must be obtained before the proposed substitute is procured by the contractor. Wherever the term "or equal" is used, it is understood to mean "or approved equal."

Where the terms "or approved equal" or "or equal" are not used, the contractor shall furnish the material as specified and no substitutions will be allowed.

1.2. *Workmanship:* These specifications contain detail instructions and descriptions covering the major items of construction and workmanship necessary for building and completing the various units or elements of the project. The specifications are intended to be so written that only first class workmanship and finish of the best grade and quality will result. The fact that these specifications may fail to be so complete as to cover all details will not relieve the contractor of full responsibility for providing a completed project of high quality, first class finish and appearance, and satisfactory for operation, all within the apparent intent of the plans and specifications.

1.3. *Handling materials not approved:* The contractor shall remove from the site any materials found to be damaged, and any materials not meeting the specifications. These materials shall be removed promptly, unless the engineer will accept the materials after repairing. Materials found to be damaged, or not acceptable to the engineer, shall be removed if installed and then found to be damaged or not acceptable. Inspection before installation shall not relieve the contractor from any responsibility to furnish good quality materials.

1.4. *Clearing and grubbing:* The contractor shall do all clearing and grubbing necessary for construction operations. All trees, branches, limbs, and roots shall be removed and disposed of by the contractor so as to leave the right-of-way in a neat and presentable condition. Clearing and grubbing shall be done so as not to injure or damage adjacent property. In disposing of brush, particular care shall be taken so as to eliminate the possibility of starting a grass fire. Any and all damages outside the limits of construction right-of-way shall be paid for and settled by the contractor at his expense.

1.5. *Safety and property protection:*

1.5.1. *Traffic control in work areas, barricades, guards and safety provisions:* To protect persons from injury and to avoid property damage, adequate barricades, construction signs, torches, red lanterns, guards, and other traffic controls as required shall be placed along all roads, street crossings, etc., and shall be maintained during the progress of the construction work and until it is safe for traffic to use the construction site. The contractor shall comply with the requirements of the Texas manual, Traffic Control Devices for Streets and Highways. A copy of the manual

may be examined at the city hall and shall be obtained by the contractor for use during construction. Excavations for construction operations shall be conducted in a manner to cause the least interruption of traffic. Where traffic must cross open trenches, the contractor shall provide suitable bridges at road crossings, street intersections and driveways.

1.5.2. *Flow of drains and sewers maintained:* Adequate provisions shall be made for the flow of storm drains and watercourses encountered during the construction and the structures which may have been disturbed shall be satisfactorily restored upon completion of the work.

1.5.3. *Property protection:* Trees, fences, signs, poles, guy wires, and all other property shall be protected unless their removal is authorized; and any property damage shall be satisfactorily restored by the contractor to its original condition or better. The contractor shall make adequate provision for the protection of permanent paving, both concrete and asphalt, from damage by construction equipment.

1.6. *Guarantee:* The contractor shall guarantee the work for a period of two years after the date of acceptance by the city. During this two year period, the contractor shall make any repairs and/or replacement of defective materials and corrections due to poor workmanship, all as may be required for full compliance with the specifications. This guarantee shall apply to all matters reported by the city in writing within said two year period, and this guarantee shall be backed by the issuance of a maintenance bond. Said maintenance bond shall be issued by a surety licensed to operate within the State of Texas, shall be for a time period of two years from the date of acceptance by the city, and shall be in an amount equal to 25 percent of the cost of construction of the work being guaranteed.

1.7. *Water for construction:* The contractor shall furnish all water required for construction. The contractor may purchase water from the city at published water rates. All connections to the city's water system shall meet the approval of the city. The contractor shall post a deposit with the city to use a city construction meter.

1.8. *Disposal of excess material:* The contractor shall dispose of all excess material.

1.9. *Material and cleanup:* During the prosecution of the work, the contractor shall maintain the project site in orderly and acceptable manner. Upon completion of any unit of work, it shall be maintained by the contractor until acceptance by the owner of the entire work covered by this contract. Upon completion, as a whole of the project, the contractor shall clean and remove from the site of the project surplus and discarded materials, temporary structures, and debris of every kind; and shall leave the site of the work in a neat and orderly condition.

1.10. *Laboratory control:* Lab work in regard to soils where paving is to be constructed shall comprise the following:

- (1) Atterberg Limits tests shall be made at intervals not exceeding 500 feet and where change in materials occurs. These tests are to be made using samples obtained from proposed subgrade areas. Tests results from the laboratory performing same shall be submitted to the city engineer along with the developer's proposed paving design so that the city can either approve the paving methods or require changes. In general, asphalt

paving subgrades have plasticity index (P.I.) of 15 or more, lime treated subgrade is to be used, and where the plasticity index is less than 10, cement treated subgrade is to be used. With the city's written approval, natural subgrade having P.I. less than 10 may be used without stabilizing material. For concrete pavement, subgrades having plasticity index in excess of 15 will require lime treatment and where the plasticity index is less than 20 a sand cushion shall be installed under the pavement.

- (2) When subgrade treatment is completed, tests shall be made to ensure that the material is properly mixed and pulverized.
- (3) When subgrade compaction and/or embankment is in progress density tests shall be made to determine whether proper density is being attained. Unless otherwise approved by the city engineer, the tests shall be performed at 300 feet maximum intervals to verify that 95 percent of Standard Proctor Density is obtained. Laboratory results shall be presented to the city, for approval, prior to construction of curbs or paving.

In addition to soil tests, laboratory work for concrete to be used in paving or curb and gutter shall consist of:

- (1) Mixing plant control for control of mix and reporting to the city, and others, to ensure compliance with the specifications.
- (2) Making and testing beams and cylinders as required for verifying compliance with specifications. Test cylinders shall be made in groups of three for 25 cubic yards, or less, placement; for one test to be made at seven days, one test at 28 days, and the remaining cylinder to be tested only if other tests appear questionable.
- (3) Preliminary tests and test cylinders for approval of mix design before construction begins may be waived by the city engineer provided the contractor can furnish a mix design from recent project that meets the specification requirements, including copies of test results to prove adequate strength. The mix and materials, however, must be from the same source that is proposed for use on this project.

The contractor shall employ a qualified commercial laboratory, and shall pay for the lab work directly. Copies of all reports shall be furnished to the city. The laboratory to perform the work shall be acceptable to, and approved by the city engineer.

(Ord. No. 87-65, § 1, 10-6-87; Ord. No. 88-64, § 1, 9-20-88)

Item 2. Street excavation.

2.1. *Description:* Street excavation will consist of all the required excavation within the limits of the right-of-way and areas adjacent thereto, the removal, proper utilization or disposal of all excavated materials; and the construction of all embankments, and the shaping and finishing of all earthwork in conformity with the lines and grades as shown on the plans or established by the engineer, all in accordance with the specification requirements contained herein. A permit will be required and a bond posted before starting construction.

2.2. *Classification:* Without regard to materials encountered, all street excavation shall be unclassified and shall be designated as unclassified street excavation which will

include all materials excavated. It is to be distinctly understood that any reference to rock, or any other material on the plans and/or in this specification is solely for the city's and the contractor's information and is not to be taken as an indication of classification of excavation.

2.3. Clearing and grubbing:

Clearing shall consist of removal and disposal of all trees, stumps, brush, logs, down timber, roots, rubbish, vegetation and other objectionable matter from the construction site. The site areas to be excavated and filled shall be cleared and grubbed.

Grubbing of roots and stumps will be required to a depth of one foot below the finish grade and to a depth of one foot below the existing ground surface in areas to receive embankment.

All cleared and grubbed material shall be disposed of in a manner satisfactory to the engineer.

2.4. Excavation:

All excavation shall be in accordance with the lines, grades, and typical sections as shown on the plans or established by the engineer. Unless otherwise shown on the plans or established by the engineer, street excavation will be made to the subgrade of the roadway and finished grade of parkways.

Where excavation to grades established in the field by the engineer would terminate in unstable soil, the engineer may require the contractor to remove the unstable soil and backfill to the required grade with suitable material compacted, in an approved manner, to a satisfactory density.

Where excavation to the grade established in the field by the engineer terminates in loose or solid rock, the contractor may be required to extend the depth of excavation six inches and backfill with select material compacted, in an approved manner, to a satisfactory density. Subject to the approval of the engineer of the select material, backfill may be obtained from any point within the right-of-way where suitable backfill material is available.

The contractor shall conduct his operations in such a manner that adequate measurements may be taken before any backfill, as required above, is placed.

A portion of the existing pavement, including both gravel base and asphalt surface, shall be thoroughly scarified, salvaged and used for the transition paving base. Care shall be taken in removing the gravel base so as not to include any of the subgrade. After removal of the pavement the excavation shall be continued to proper grades and then treated in accordance with Item 4 [of this article].

2.5. Provisions for drainage: If it is necessary in the prosecution of the work to interrupt the natural drainage of the surface, or the flow of artificial drains, the contractor shall provide temporary drainage facilities that will prevent damage to public or private interests, and shall restore the original drains as soon as the work will permit. The contractor shall be held liable for all damages which may result from neglect to provide for either natural or artificial drainage which his work may have interrupted.

2.6. Embankment:

After the site has been cleared, the ground surface upon which embankments are to be constructed shall be scarified in furrows uniformly spaced so that at least 50 percent of the surface will be broken to a depth of at least four inches.

Backfilling and construction of fills and embankments during freezing weather shall not be done except by permission of the city engineer. No backfill, fill, or embankment materials shall be installed on frozen surfaces, nor shall frozen materials, snow or ice be placed in any backfill, fill or embankment.

Embankments shall be constructed of suitable materials and shall be placed in successive horizontal layers of not more than eight inches in depth, loose measurement, for the full width of the embankment and in such lengths as designated. Stumps, trees, rubbish, vegetation or other unsuitable materials shall not be placed in embankments. All construction traffic shall be uniformly distributed over the entire surface of each layer of the embankment.

A maintainer with a blade at least ten feet in length shall be kept in operation on the embankment for the purpose of uniformly mixing, spreading, pulverizing, and consolidating the embankment material.

After a layer of embankment material has been placed and bladed, it shall be sprinkled, if directed, in the quantity as determined by the engineer, and rolled to compaction with a tamping roller, or approved type, drawn by a suitable crawler-type tractor. The roller shall pass over every part of each layer for a minimum of six times. In the event water from the city water mains is used, it shall be metered and paid for by the contractor.

No successive layer shall be placed until the layer under construction has been thoroughly bladed and rolled to the satisfaction of the engineer.

After a section of the embankment has been completed, it shall be maintained to grade and cross section by blading when and to the extent required.

Embankments placed over and adjacent to pipes, culverts, and other structures shall be of suitable materials, and shall be placed in successive horizontal layers of not more than eight inches in depth, loose measurement, and each layer uniformly mixed, pulverized and thoroughly compacted to the satisfaction of the engineer by the use of rakes, hand tamps, and/or other approved methods. Special care shall be taken to prevent any wedging against the structure. This method of consolidation and compaction shall be used for such distances along embankment adjacent to structures as may be necessary and in other areas where blading and rolling would be impractical.

2.7. Embankments containing rock:

Where a large portion of the materials excavated consist of rock, the rock may be used in the construction of the embankment as hereinafter specified.

The maximum dimension of any rock used shall not exceed 50 percent of the height of the embankment and in no case shall any rock over 24 inches in its maximum dimension be placed in the embankment. When the greater portion of the embankment shall be constructed as required in the preceding paragraphs, the rock shall be carefully distributed throughout the embankment and filled around with earth or other approved fine material so that the interstates between the large particles are filled and a dense, compact, uniform embankment is

secured.

When embankments are to be constructed principally of the rock, the rock shall be placed in successive horizontal layers, not to exceed 30 inches in depth, for the full width of the embankment and the interstates between the large stones filled, insofar as practicable, with small stones and spalls.

The upper eight inches of all embankments shall be composed of earth or other acceptable material.

2.8. *Excess excavation:* Unsuitable street excavation and suitable street excavation in excess of that needed for construction shall be disposed of as directed by the engineer. In general, suitable excess street excavation will be used in the construction of parkways, widening of embankments, flattening of slopes, etc., but if necessary to waste any material, it shall be disposed of in such a manner as to present a neat appearance and to no obstruct proper drainage or cause injury to street improvements or to abutting property.

2.9. *Subgrade finish:* The subgrade will be accurately finished to the required grade using pneumatic rollers, blading equipment, and sprinkling as necessary for an accurate, smooth finish. Compaction will be required to 95 percent Standard Proctor Density. All embankment shall be compacted in lifts to 95 percent Standard Proctor Density.

Item 3. Concrete and reinforcing steel (structures).

3.1. *General:* Concrete shall be composed of portland cement, fine aggregate, coarse aggregate, water and water-dispersing agent properly proportioned and mixed as hereinafter specified. All structural concrete shall be 3,000 pounds per square inch quality unless otherwise shown on the plans.

3.2. *Materials:*

Portland cement shall conform to the specifications and tests for Type I portland cement of the American Society for Testing Materials, Serial Designation C-150.

Fine aggregate shall conform to the Standard Specification for Concrete Aggregate, American Society for Testing Materials Designation C-33. In addition to the requirement of the American Society for Testing Materials Specifications, the fine aggregate shall also conform to the following:

1. Loss shall not exceed ten percent by weight in five cycles when tested for soundness in accordance with American Society for Testing Materials Method of Test Designation C-88, except as noted in American Society for Testing Materials Specification Designation C-33.
2. The amount of deleterious substances shall not exceed recommended permissible limits as set forth in American Society for Testing Materials Specification Designation C-33, and other deleterious substances will not be allowed.
3. The mortar, for test of fine aggregate, made and tested in accordance with Standard Method of Test for Measuring Mortar-Making Properties of Fine Aggregate, American Society for Testing Materials Designation C-87, shall develop a comprehensive strength at seven and 28 days of not

less than 100 percent of that developed by the motor specified in the method as the basis of compensation.

Coarse aggregates shall conform to the Standard Specifications for Concrete Aggregates, American Society for Testing Materials Designation C-33. In addition to the requirements of the American Society for Testing Materials Specifications, the coarse aggregate shall also conform to the following:

1. Wear shall not exceed 40 percent when tested according to American Society for Testing Materials Standard Method for Abrasion of Coarse Aggregates by Use of the Los Angeles Machine, Designation C-131.
2. Loss shall not exceed 13 percent by weight in five cycles when tested for soundness in accordance with American Society for Testing Materials Method of Test Designation C-88, except as noted in American Society for Testing Materials Specification Designation C-33.
3. The amount of deleterious substances shall not exceed recommended permissible limits as set forth in American Society for Testing Materials Specifications Designation C-33, and other deleterious substances will not be allowed.

For the contractor's convenience, the American Society for Testing Materials grading requirements applicable to this project are listed hereinafter:

Fine Aggregate

TABLE INSET:

Sieve size	% passing
3/8 inch	100
No. 4	95-100
No. 8	80-100
No. 16	50-85
No. 30	10-60
No. 50	10-30
No. 100	2-10

Coarse Aggregate

TABLE INSET:

Sieve size	% passing
Sq. openings	
2 inches	100
1 1/2 inches	95-100
3/4 inch	35-70
3/8 inch	10-30
No. 4	0-5

Water for concrete shall be clean and free from oil, acid, alkali, organic matter, or other harmful impurities. Water which is suitable for drinking or for ordinary household use will be acceptable for concrete. Where available, water shall be obtained from mains or a waterworks system._____

3.3. Concrete proportions and consistency:

Concrete shall be proportioned to give the necessary workability and strength and shall conform to the following requirements:

TABLE INSET:

<i>Min. 28-day compressive strength</i>	<i>Min. cement bags per cubic yard</i>	<i>Max. size of coarse aggregate in inches</i>	<i>Max. water gals. per bag</i>	<i>Slump inches</i>
3000	5.5	1 ½	6.75	4-6
2500	5.0	1 ½	7.00	4-6
1500(cradle)	4.0	1 ½	8.00	3-4
Stabilized backfill	2.0	3*	8.00	3-4

* May be pit run aggregate.

The proportion of fine and coarse aggregate shall be such that the requirements of the following table are complied with:

TABLE INSET:

<i>Max size of coarse aggregate in inches</i>	<i>Ratio of coarse aggregate on rodded volumes</i>	<i>aggregate to fine basis of dry and</i>
	<i>Minimum</i>	<i>Maximum</i>
¾	0.6	1.5
1 and over	1.0	2.0

In no case shall the amount of coarse material be such to produce harshness in placing and honeycombing in the structure when forms are removed.

In the determination of the amount of water required for mix, consideration shall be given to the moisture content of the aggregate. The net amount of water in the mix will be the amount added at the mixer; plus the free water in the aggregate; and minus the absorption of the aggregate, based on 30 minutes absorption period. No water allowance will be made for evaporation after batching.

The methods of measure of materials shall be such that the proportions of water to cement can be closely controlled during the progress of the work and easily checked at any time by the engineer or his representative. To avoid unnecessary or haphazard changes in consistency, the aggregates shall be obtained from a source which will ensure uniform quality and grading during any single day's operation and they shall be delivered to the work and handled in such a manner that the variations in moisture content will not interfere with the steady production of concrete of reasonable degree of uniformity. All sources of supply shall be approved by the engineer.

All materials shall be separately and accurately measured. Measurement may be made by weight or by volume, as may be elected by the contractor; however, all equipment for measurement of materials shall be subject to approval by the engineer.

The proportions of the mix shall be such as to produce concrete that can be puddled readily into the corners and angles of the forms and around the reinforcing without excessive spading, and without segregation of undue

accumulation of water or laitance on the surface.

3.4. *Trial mixes:*

At least 35 days prior to the beginning of concrete placing, the contractor shall submit samples of materials he proposes to use and a statement of proportions proposed for several concrete mixes, having sufficient range in slump to cover all placing conditions. The engineer will require that laboratory tests be made and such changes as may be necessary to meet the requirements of the specifications. Laboratory tests on trial mixes shall show a 28-day strength 15 percent higher than the stated minimum 28-day strength. From these preliminary tests, the ratios between seven-day and 28-day strengths shall be established to determine at seven days the strength necessary to satisfy the required 28-day strengths. These ratios shall be modified as the work progresses as indicated by result of tests on cylinders made from field mixed concrete.

If, during the progress of the work, it is found impossible to secure concrete of required workability and strength with the materials being furnished by the contractor, the engineer may order changes in proportions or materials, either graduation, source or brand, or proportions of the mixture after their having once been approved except by specific approval of the engineer.

The contractor shall have the preliminary testing done by an approved testing laboratory, and shall pay for all preliminary tests on aggregates and test cylinders.

If the contractor can provide mix design and satisfactory test cylinder record from a recent job using same materials, then the preliminary test requirement will be waived.

3.5. *Transit mix concrete:* Transit mix concrete will be permitted in lieu of mixing on the job, provided all of the following are complied with:

- (1) All requirements otherwise specified for mixing on the job shall apply.
- (2) Sufficient transit mix equipment shall be assigned exclusively to the project as required for continuous pours.
- (3) Satisfactory evidence shall be furnished that the delivery of concrete shall be continuous at regular and uniform intervals without stoppages or interruptions.
- (4) All concrete shall be deposited in the forms within 45 minutes after water has been added to the mix. Concrete retained in the truck longer than 45 minutes after water has been added to the mix will be rejected.

3.6. *Testing and control of mix during construction:*

Sufficient test cylinders will be made by the engineer at intervals to determine compliance with the specifications. Compression tests of concrete cylinders will be made by an independent testing laboratory, selected and paid by the developer and/or contractor. The selection of the laboratory shall be subject to approval by the city.

The control of proportioning and mixing of all ready mix, transit mix or central plant concrete shall be under the supervision of a trained representative of an

established independent testing laboratory, which laboratory has been approved by the owner. The laboratory representative shall work in cooperation with the engineer, and shall furnish to the engineer a summary of all tests which are performed and for each concrete pour shall furnish a certificate of compliance with the specification. No concrete shall be poured without the laboratory representative being present at the batching plant.

All cost for services of the testing laboratory, except those tests in connection with the mix design and trial batches at the beginning of the project shall be borne by the owner. Tests are required for initial batch designs shall be paid for by the contractor.

For concrete pours of ten cubic yards or less, the engineer may waive the requirements for a laboratory technician.

3.7. Forms:

Forms shall be built mortartight, and true to line and grade, Studs, walers, and approved form ties shall be used at the proper spacing and be of the proper size to maintain straight lines on all vertical surfaces. Forms for surfaces requiring a rub finish shall be lined with plywood, Masonite or other approved form lining.

Forms on vertical surfaces shall remain in place a minimum of six hours. Forms under horizontal surfaces shall remain in place seven days.

3.8. Placing concrete:

The contractor shall give the engineer at least 24 hours advance notice before starting to place concrete in any unit of the structure to permit the inspection of forms, the reinforcing steel placement, and preparation for pouring. Unless authorized by the engineer, no concrete shall be placed in any unit prior to the completion of the form work and the placement of the reinforcement.

The sequence of placing concrete shall be as provided on the plans or in the specifications. The operation of depositing and compacting the concrete shall be conducted so as to form a compact, dense, impervious mass of uniform texture which shall show smooth faces on all surfaces. The placing shall be so regulated that the pressures caused by the plastic concrete shall not exceed the loads used in the design of forms.

Careful attention shall be given by the Contractor to the proper curing of all concrete.

3.9. Freezing weather:

When depositing concrete at or near freezing temperatures, the concrete shall have a temperature of at least 50 degrees Fahrenheit, but not more than 120 degrees Fahrenheit, when aggregates are heated. The concrete shall be maintained at a temperature of at least 50 degrees for not less than 72 hours after placing, or until the concrete has thoroughly hardened. When necessary, concrete materials shall be heated before mixing and heating apparatus such as stoves, salamander, etc., shall be supplied to maintain the concrete at the required temperature. The contractor shall be responsible for the protection of concrete placed under any and all water conditions.

Concrete shall not be placed on frozen or thawing base and shall not be poured

when temperature is 40 degrees Fahrenheit and falling. Concrete may be placed when temperature is 35 degrees Fahrenheit and rising.

3.10. *Curing:*

All concrete shall be cured by keeping continuously wet for seven days after pouring. On surfaces which do not require a rubbed finish, the concrete may be cured by supplying a curing compound in lieu of water curing if the contractor so desires. Curing compound shall be Hunts Process or approved equal applied as closely behind concrete finishing as possible.

3.11. *Rub-finished exposed surfaces:*

The following exposed vertical concrete surfaces shall be given a rubbed finish: The exposed vertical surfaces to a point one foot below the final ground line.

The rubbing operation shall be in accordance with the following provisions: As soon as forms are removed, all necessary painting shall be done. When the painting has set sufficiently to permit it, all surfaces requiring surface finish shall be wet with a brush and given a first surface rubbing with a No. 16 Carborundum stone or an abrasive of equal quality. The rate of removal of forms shall be determined by the rate of the complete rubbing. The rubbing shall be continued sufficiently to bring the surface to a paste, to remove all forms, marks and projections, and to produce a smooth dense surface without pits or irregularities. The use of cement to form a surface paste will not be permitted. The material which has been ground to a paste in this process shall be carefully spread or brushed uniformly over the surface and allowed to take a reset. In general, chamfered corners shall not be rubbed in the first surface rubbing. During the process of conditioning the completed structure for final acceptance, the surfaces of the entire structure requiring finish shall be cleaned free from drip marks and discolorations and shall be given a final finish rubbing with a No. 30 Carborundum stone or an abrasive of equal quality. On completion of this rubbing, the surface shall be neatly stripped with a brush and mortar and the surface shall be allowed to take a reset. The surface shall then be washed down with clean water. The entire structure shall be left with a clean, neat and uniform appearing finish and shall be uniform in color.

3.12. *Reinforcing steel:* Reinforcing steel shall be billet steel, intermediate grade, deformed bars, conforming to American Society for Testing Materials Specification A-15, or shall be rail steel, deformed bars conforming to American Society for Testing Materials Specifications A-16. All mill scale shall be removed before placing and bars shall be kept clean until concrete is placed. The steel shall be placed in the forms as shown on the plans and shall be maintained in place by wiring or by any other effective means approved by the engineer.

Item 4. Subgrade treatment.

4.1. *General:*

Excavation and embankment shall be performed in accordance with Item 2 and then treated as herein specified. Subgrades for all asphalt paving shall be scarified and treated with either hydrated lime or Portland cement for the width of pavement back-to-back of curbs plus six inches on each side, with minimum depth of six inches for residential streets, 6 1/2 inches for secondary streets and

seven inches for major and industrial streets.

Where concrete pavement is to be placed on subgrade having plasticity index of less than 20, the subgrade stabilization using lime or cement may be omitted. In such cases the concrete is to be placed on two-inch thick sand cushion that is placed on the finished subgrade. The concrete is to be poured directly on the sand cushion. The sand material used for this purpose shall be granular material having a plasticity index of not to exceed 7. It is not required that this material be a washed and graded sand, but it is intended that the material be free of clay lumps and other plastic materials. No grading requirement is necessary other than the requirement that no rock or other particles in the mix shall exceed three-fourth-inch maximum size. Where sand cushion is used, the subgrade shall be finished accurately to a grade two inches below the bottom of the concrete slab. The sand cushion materials shall be applied on this subgrade and accurately finished to a uniform thickness of two inches. In such cases where there may be a slight inaccuracy in the subgrade elevation, such inaccuracies may be corrected by the variation in thickness of the sand cushion. It is not required that the sand cushion be compacted, but it shall be uniformly finished and sprinkled where there is any tendency for it to be blown or shifted by the wind.

4.2. *Subgrade treatment:* Subgrades for all asphalt pavement, and concrete pavement where plasticity index is 15 or more, or where plasticity index is 10 or less shall be treated with either hydrated lime or portland cement.

4.2.1. *Lime treatment:*

If natural subgrade consists of a dirt or a mixture of dirt and clay, and has a plasticity index of 15 or more, lime treated subgrade shall be used. If required, tests by an independent laboratory shall be made prior to preparation of paving plans.

All materials and construction shall comply with the requirements of 1972 Texas Highway Department Specifications, Item 260, with six percent by weight of hydrated lime added (4 1/2 pounds per inch of depth per square yard) and compacted to 95 percent of Standard Proctor Density.

If requested by the contractor, independent laboratory tests may be made to determine any reduction in the amount of lime required to reduce the plasticity index to a maximum of 10, but in no case shall less than two percent of lime by weight be used. The city's engineer must approve this reduction in the amount of lime.

4.2.2. *Cement treatment:*

If natural subgrade consists of sandy material, and has a plasticity index of less than 10, cement treated subgrade shall be used for asphalt pavement.

All materials and construction shall comply with 1972 Texas Highway Department Specifications, Item 270, with six percent by weight of portland cement added (five pounds per inch of depth per square yard) and compacted to 95 percent Standard Proctor Density.

If requested by the contractor, independent laboratory tests may be made to determine any reduction in the amount of cement required, but in no

case shall less than two percent of cement by weight be used. The city's engineer must approve this reduction in amount of portland cement.

4.3. *Material requirements:* Hydrated lime to be used for soil stabilization shall meet requirements of Texas Highway Department Specifications, Item 264. Portland cement to be used for soil stabilization shall meet requirements of Texas Highway Department Specifications, Item 270.

4.4. *Construction methods:* It is the intent of this specification to require the stabilizing material to be thoroughly and uniformly mixed with the subgrade material, with the proper moisture content, and that mixing be continued using property equipment until the lime, or cement, is thoroughly mixed and the soil is thoroughly pulverized so that no clods or chunks remain. Some form of pulverizing equipment will be required, such as those machines designed to work on a window and thoroughly pulverize the material. Mixed and wetted material shall be pulled out of the window in thin layers, bladed and rolled and thoroughly compacted until the finished grade is attained. In general, the mixing, compaction, finishing and curing shall comply with Texas Highway Department Specifications Item 262 for lime stabilization and Specifications Item 270, for portland cement stabilization.

Item 5. Concrete paving.

5.1. *General:* The specification covers the construction of concrete paving. The typical section and the elevations for paving shall be as shown on the plans. Subgrade treatment will be dependent upon the plasticity index of the native soil at subgrade level. The typical section for each of these conditions shall be shown on the plans.

5.2. *Cement:* Cement shall be Type I in accordance with American Society for Testing Materials 150 and Texas Highway Department Specifications, Item 360.

5.3. *Admix:* None required.

5.4. *Coarse aggregate:* Coarse aggregate shall conform to Texas Highway Department Specifications, Item 360, and the grading from that specification is quoted as follows:

Retained on 1 3/4-inch sieve . . . 0%
Retained on 1 1/2-inch sieve . . . 0--5%
Retained on 3/4-inch sieve . . . 30--65%
Retained on 3/8-inch sieve . . . 70--90%
Retained on No. 4 sieve . . . 95--100%

5.5. *Fine aggregate:* Fine aggregate shall comply with Texas Highway Department Specifications, Item 360, and the grading from that specification is quoted as follows:

Retained on 3/8-inch sieve . . . 0%
Retained on No. 4 sieve . . . 0--5%
Retained on No. 8 sieve . . . 0--20%
Retained on No. 16 sieve . . . 15--30%

Retained on No. 30 sieve . . . 35--75%

Retained on No. 50 sieve . . . 70--90%

Retained on No. 100 sieve . . . 90--100%

Retained on No. 200 sieve . . . 97--100%

5.6. *Water:* Water as used in concrete mix for this project shall generally comply with the requirements of portable water, and further, shall comply with Texas Highway Department Specifications, Item 360.

5.7. *Proportioning of concrete:* Concrete mix for paving shall conform to Texas Highway Department Specifications, Item 364.2, Class A Concrete. A part of the requirements of the Texas Highway Department Specification is listed as follows:

TABLE INSET:

Minimum sacks of cement per cubic yard	5
Minimum compressive strength at 28 days	3,000 pounds per square inch
Maximum water cement ratio	6.5 gallons per sack
Slump range	1 to 3 inches
Minimum flexural strength at 7 days	575 pounds per square inch

5.7.1. *Mix design:* The contractor shall prepare a mix design through a commercial laboratory and report compressive and flexural test results to the engineer prior to the beginning of paving work. Gradation tests of the aggregate used in the mix shall also be reported. This laboratory work shall be paid for by the contractor.

5.7.2. *General characteristics of mix:* The workability and other general characteristics of the mix shall conform to the requirements of Texas Highway Department Specifications, Item 360.4.

5.8. *Reinforcing steel:* Reinforcing steel shall be provided in the sizes and lengths as shown on the plans and shall be properly tied and supported at the positions in the slab as indicated. Reinforcing steel shall otherwise conform to Texas Highway Department Specifications, Item 360.2.

5.9. *Placing and removing forms:* The subgrade under forms shall be accurately cut so that the form has firm support for its length. Forming and removal of forms for concrete paving shall in general comply with Texas Highway Department Specifications, Item 360.6, with some of the essential requirements listed as follows:

1. On-site mixers are preferred and transit mix concrete will require a special permit from the engineer.
2. Mixing and batching equipment is subject to the engineer's approval.
3. Mixing time shall not be less than 50 seconds nor more than 90 seconds after all ingredients are in the drum.
4. All concrete must be placed within 30 minutes from beginning of the mixing operation.

5.10. *Reserved.*

5.11. *Pavement subgrade:* Where subgrade is lime or cement stabilized, the

finishing shall be to a tolerance of one-fourth inch before primer is applied. Where a sand cushion is provided for the subgrade, a subgrade planner shall be provided for mounting on forms in accordance with Texas Highway Department Specifications, Item 360.3. The forms shall be metal forms in accordance with Texas Highway Department Specifications, Item 360.3.

5.12. *Concrete spreader*: A self-propelled concrete spreader and strike-off machine will be required in accordance with Texas Highway Department Specifications, Item 360.3.

5.13. *Vibratory equipment*: Mechanical vibratory equipment in accordance with Texas Highway Department Specifications, Item 360.3, will be required and shall be operated ahead of the transfer finishing machine. Complete consolidation of concrete will be required.

5.14. *Spreading and finishing*: Wherever possible the concrete paving shall be finished with a power-drive machine. Hand finishing will be permitted at intersections and other places where machine finishing is not feasible. Spreading, compacting and finishing shall comply in general with Texas Highway Department Specifications, Item 360.8.

5.15. *Optional equipment*: The contractor, at his discretion, may use a traveling form paver. All other requirements are to be complied with.

5.16. *Finishing equipment*: The finishing machine shall be designed to ride on the forms and to accurately finish the surface to the specified grades. In general, finishing equipment shall conform to Texas Highway Department Specifications, Item 360.3.

5.17. *Construction joints*: Stoppage of concrete placement shall be either at an expansion joint or at a construction joint. Construction joints and weakened plane joints shall have continuous reinforcing steel through the joint and shall comply in general with Texas Highway Department Specifications, Item 360.6.

5.18. *Expansion joints*: Joint assembly, including dowels and premolded filler, shall be as shown on the plans. A removable strip shall be placed at the top of the premolded filler so that it can be removed and the sealer material installed. The joint sealer shall be hot poured rubber in accordance with Texas Highway Department Specifications, Item 360.2, Class 2. Before applying the sealer material, the joint surfaces shall be clean and dry, and free of curing compound, oil or any other material that would prevent the sealer from adhering to the concrete surface. The premolded filler shall be PVC foam joint filler, such as Rodofom as manufactured by Electrovert, Inc. The grade of the material shall be semirigid. Expansion joints shall otherwise conform to Texas Highway Department Specifications, Item 360.7.

5.19. *Other joints*: Weakened plane joints (sawed joints), contraction joints, and longitudinal joints shall comply with the details shown on the plans. In addition to the plan requirements, the construction of these joints shall comply with Texas Highway Department Specifications, Item 360.7.

5.20. *Protection from traffic*: This contractor shall place barricades and otherwise protect the slab to ensure that no traffic gets on the slab until it has cured for at least seven days.

5.21. *Curing*: Immediately after finishing operations have been completed, the concrete shall be cured with either water cure or membrane curing compound. Water

curing may be done with mats or other approved methods that would ensure the concrete is kept wet for a minimum of 72 hours. Curing compound where used shall comply with Texas Highway Department Specifications, Item 360.2. Curing of concrete, whether by water cure or curing compound, shall comply with Texas Highway Department Specifications, Item 360.10.

5.22. *Superimposed curb*: The superimposed curb shall be constructed as shown on the plans. Joints in the curb shall match joints in the pavement. Concrete for the curb shall be proportioned similar to that for the paving, with the exception that a top size of one inch aggregate shall be used. The superimposed curb is a small exposed section, and particular attention shall be given to proper curing of this item.

5.23. *Grade and alignment*: At the beginning of this project, the engineer will provide tack pointed offset stakes at intervals of 100 feet. These stakes will be offset from the back of the outside curb a convenient distance to permit all operations without disturbing this stake. Information given on these stakes will be as follows:

1. Station number
2. Offset distance from back of curb
3. Elevation of hub will be given in tabular form separately

It will be this contractor's responsibility to maintain these stakes and to use this information for all other horizontal and vertical control required. This contractor will be required to furnish experienced personnel to do this work. The plans will show top of curb elevation for the median curb and for the outside curbs. This contractor will set all forms using this data, blue tops for fine grading subgrade, and all other vertical and horizontal control required.

5.24. *Testing and quality control during construction*: This contractor shall furnish the following at his own cost and expense:

1. Batch plant control from a qualified commercial laboratory. This person shall be competent to determine free moisture in aggregates and make needed adjustments in control of the mix and the slump.
2. Make four compression test cylinders each day, with two to be broken at seven days and two to be broken at 28 days.
3. Make two test beams of each day's paving operation to be broken at seven days.
4. Report test results to contractor and city.

This contractor shall provide proper curing facilities for the test specimens in accordance with the applicable American Society for Testing Materials specifications.

Item 6. Asphaltic concrete pavement.

6.1. *General*: This item shall consist of a binder course, a levelling-up course, a surface course, or any combination of these courses as shown on the plans each to be composed of a compacted mixture of mineral aggregate and asphaltic materials, and shall be constructed on the previously completed and approved subgrade, subbase course, base course, all in accordance with these specifications and in conformity with the lines, grades, quantities and typical sections as shown on the plans and/or

established in the field by the engineer. The materials and methods shall be as specified herein.

6.1a. *Laboratory tests:* In addition to the tests required for subgrade, the contractor shall provide for services of approved laboratory to perform tests for the asphaltic concrete. The laboratory shall furnish, through the contractor, a design mix and the laboratory shall provide batch control for the hot-mix asphaltic concrete. The laboratory shall make two density tests for each block of pavement and one stability test for the project. Upon completion of the work and before final acceptance and final payment, pavement thickness tests shall be made by core drilling at least two locations per block.

6.2. *Materials, equipment and methods:* Materials, equipment and construction shall be in accordance with Texas Highway Department Specifications, Item 340, except as may be herein modified. Coarse aggregate shall be limited to crushed limestone.

6.2.1. *Prime coat:*

The asphaltic material for prime coat shall meet the requirements for cut-back asphalt RC-2 or MC-1, 1972, Texas Highway Department Specifications, Item 300 and Item 312.

The primer coat shall be applied, as directed by the engineer, with an approved sprayer at a rate not less than 0.3 gallon per square yard of surface. All contact surfaces of gutters, manholes, valve boxes, structures, etc., shall be painted as required and directed by the engineer.

Prime coat shall not be applied when the air temperature is below 60 degrees Fahrenheit and falling but it may be applied when the air temperature is above 50 degrees Fahrenheit and is rising. Asphaltic material shall not be placed when general weather conditions, in the opinion of the engineer, are not suitable.

6.2.2. *Tack coat:* The asphaltic material for tack coat shall meet the requirements for cut-back asphalt RC-2 or MC-2, American Society for Testing Materials D-597-46, and D-598.46. Before the asphaltic mixture is laid, the surface upon which the tack coat is to be placed shall be cleaned thoroughly to the satisfaction of the city engineer. The surface shall be given a uniform application of tack coat applied, as directed by the engineer, with an approved sprayer at a rate not to exceed 0.1 gallon per square yard of surface. Where the mixture will adhere to the surface on which it is to be placed without the use of a tack coat, the tack coat may be eliminated if approved by the city engineer. All contact surfaces of curbs and structures and all joints shall be painted with a thin uniform coat of the asphaltic material for tack coat. The tack coat shall be rolled with a pneumatic tire roller when directed by the city engineer.

6.2.3. *Hot-mix asphalt:*

The hot-mix asphaltic concrete shall comply with the requirements of 1972 Texas Highway Department Specifications, Item 340 (Class A), with coarse aggregate limited to crushed limestone. After the prime coat has been absorbed by the subgrade, it shall be surfaced with hot-mix asphaltic concrete of the minimum thicknesses for the various types of streets as follows:

TABLE INSET:

Type of Street	Asphalt Thickness	No. and depth layers
Residential	5"	Two--3 ½" and 1 ½"
Secondary	6 ½"	Three—3", 2", and 1 ½"
Major and industrial	7"	Three—3", 2 ½", and 1 ½"

The paving mixtures shall be for a coarse graded base course and for a coarse graded surface course, with a laboratory density between 94 and 98 percent and laboratory stability of not less than 45 nor more than 55.

The contractor will be required, at his expense, to furnish continuous plant control of the hot-mix asphaltic concrete mixture by securing the services of an independent testing laboratory approved by the city, as per Texas Highway Department Specifications, Item 6.1.

6.3. *Penalty for deficient thickness:* When the average thickness is consistently less than the thickness specified (cores to be taken as directed by the city engineer), the city shall require an overlay for the full width of pavement between gutter of required thickness, but in no case less than one-half inch, at the contractor's expense, or the city shall have the option of assessing a penalty against the contractor or the developer which shall be paid to the city on the following basis: When the average thickness of the hot-mix surface in a block or any area of 20 square yards or more within the block, is consistently less than the thickness specified, but not more than one-half inch deficient, the unit price of the deficient areas shall be reduced by a penalty per square yard that will be computed as follows:

TABLE INSET:

	X average deficiency	
Penalty =	-----	X unit price
	specified thickness	

For assessment of penalty, the city shall be furnished a certified copy of the contractor's proposal to the developer showing the unit price for the hot-mix surfacing, or the city may determine the unit price from average unit prices prevailing in the vicinity.

Item 7. Storm drains.

7.1. *General:* The city engineer shall have the right to limit the amount of trench that shall be opened or partially opened at any time in advance of the installation and also the amount of the trench not backfilled.

7.2. *Classification:* Without regard to materials encountered, all trench excavation shall be unclassified and shall be designated as unclassified trench excavation. It is to be distinctly understood that any reference to rock or any other material on the plans or in the specifications is solely for the owner's and contractor's information and is not to be taken as an indication of classification.

7.3. *Shoring and sheathing:* Whenever necessary the sides of the trench shall be braced and rendered secure, and either open or closed sheathing used, as directed by the engineer. Sheathing and bracing shall remain in place until the trenches are backfilled. Such sheathing and bracing shall be done at the contractor's expense, unless left permanently in place by order of the engineer, in which case such sheathing and

bracing, and only such, will be paid for as an extra, unless otherwise provided for. When left in trenches, sheathing shall be cut off one foot below the surface of natural ground or street subgrade.

All trenches that are required to be excavated to a depth in excess of five feet shall be excavated and maintained in a manner that meets all Occupational Safety and Health Administration standards. The contractor shall provide the city, prior to excavation and construction of the trench(es), with detailed plans and specifications for record, certified by a registered professional engineer, that provide for adequate safety systems that meet the Occupational Safety and Health Administration standards. The detailed plans and specifications shall include requirements for a safety program for the trench system.

7.4. Interference with existing structures:

In excavating and backfilling trenches, special care must be taken not to remove or injure any existing gas, water, sewer, or other pipes, conduits or structures without explicit instructions by the engineer. If necessary, the contractor shall, at his own expense, sling, shore up and/or otherwise secure and maintain a continuous flow in said structures or conduits and shall repair any and all damages done to them. Furthermore, the contractor shall maintain the said structure of conduits in good repair until acceptance of the completed work and shall leave them in as good condition as when encountered.

Should it be necessary to relocate utility lines that lie within the storm drain section, the respective utility owning the line or lines will relocate the said line or lines at no cost to the contractor. The contractor shall notify the utility concerned a sufficient amount of time in advance and provide suitable access to the work so that a minimum of interference and inconvenience to all parties concerned is affected.

All fire hydrants shall be left uncovered and accessible. The contractor shall, at his own expense, provide for all watercourses, gutters and drains interrupted by the work and shall replace those located outside the limits of the existing or proposed pavement in as good condition as he found them.

7.5. Trench excavation:

The excavated trench must be wide enough for satisfactory joint work and backfilling.

In case a firm foundation is not encountered at the grade established by the engineer, the city engineer may direct the contractor to remove the unstable material to a depth which will produce a uniform and stable foundation when backfilled with gravel. The grade shall be refilled to a proper elevation with gravel of a quality satisfactory to the city engineer, and thoroughly compacted.

When rock is encountered in trench excavation, the trench shall be excavated to a minimum depth of six inches, below the bottom of the pipe, refilled with sand or gravel of a quality satisfactory to the city engineer, and thoroughly compacted to form a uniform bedding for the pipe.

Should the trenches be excavated below the grade shown on the plans, or established by the engineer, they shall be refilled to the proper grade with gravel of a quality satisfactory to the engineer, and thoroughly compacted.

7.6. Precast concrete pipe:

Precast concrete pipe shall be manufactured in accordance with American Society for Testing Materials Specification C-76-64T, Table III with Wall A thickness and circular reinforcement.

A certificate of test from an approved independent testing laboratory shall be furnished for all concrete pipe, and the laboratory's stamp of approval shall be placed on each joint of pipe to be used in the work.

The cost of the laboratory testing and stamping will be paid for by the contractor and will be considered as subsidiary work pertaining to the various items of the contract.

Shop made specials shall be used for the connection of all intersecting pipes where the main line is 30 inches in diameter or smaller and a manhole is not be constructed. The angle of intersection of the specials shall be 60 degrees.

7.7. Cause for rejection: In addition to the requirements listed under the American Society for Testing Materials specifications, the pipe will be subject to inspection at all times prior to placing. The pipe will be subject to rejection if it fails to comply with the American Society for Testing Materials specifications or because of any of the following:

1. Where permissible variations are exceeded.
2. Failure to give a clear ringing sound when placed on end and tapped with a light hammer.
3. Exposed or misplacement of reinforcement.
4. Incomplete or improper mixing of the concrete.
5. Unauthorized patching.
6. Cracks sufficient to impair the strength, durability or serviceability of the pipe.
7. Porous spots on either the inside or outside of the pipe.
8. Insecure attachment of spurs or branches.

7.8. Installing pipe:

Prior to being placed in the trench, each section of pipe shall be carefully inspected. Sections of pipe not meeting the requirements shall be permanently removed from the work within ten hours after rejection.

All lumps or excrescences on the ends of the pipe sections shall be removed before being placed in the trench. No pipe shall be placed except in the presence of the city engineer's representative and the representative may order the removal and relaying of pipe not so placed. Pipes having minor defects (defects of a nature not sufficiently serious to cause their rejection) shall be placed so as to bring such defects to the top half of the pipe when installed.

Mortar for the joint shall be of one part portland cement and two parts brick sand by volume, with hydrated lime added in the amount of ten percent of cement by volume. The completed joints shall be protected from drying out by Hunt's

Process or equal membrane curing compound. Ram-Nek type joints may be used with the city's approval.

Before laying the interior of the socket shall be carefully wiped smooth and clean, and the annular space shall be kept free from dirt, stones or water.

During laying, the ends of the pipe shall be cleaned and moistened immediately before laying so that when the mortar is placed against the tongue and groove, the pipe shall not absorb moisture from the mortar. No free surface water shall be on the pipe when mortar is placed.

The contractor shall remove all water from the excavation by pumping, bailing or draining, as all trenches and other excavated areas must be free from water when pipe is laid, and/or concrete is placed.

All pipe shall be laid carefully, socket up grade, spigot end fully extended into the adjacent socket and true to line and grade given. Each section shall have a full firm bearing throughout its length. All joints shall be tightly fitted together and completely filled with mortar composed of one part cement and two parts sand. The mortar shall be placed so as to form a durable watertight joint. After any section of pipe is laid and before any succeeding section is placed, the lower portion of the socket of the pipe in place and the upper portion of the spigot of the succeeding section shall be plastered thoroughly with mortar to such a depth and in such a manner as to bring the inner surfaces of the abutting pipes flush and even when in place.

After the succeeding section is laid, the remainder of the joint shall be completely filled with mortar (inside and outside the pipe) and sufficient additional mortar shall be used to form a bead around the outside of the joint. The inside of the joint shall then be wiped and finished smooth.

The inside of small diameter pipe shall be wiped clean with a wad made of a sack filled with hay and large enough to tightly fill the pipe. The wad shall be attached to a rod or cord; shall at all times be kept in the pipe and shall be pulled ahead past each joint as soon as the joint is finished. Completed joints shall be immediately covered with burlap and kept wet until backfill is placed.

7.9. Embedment and backfill within rights-of-way:

- (1) Gravel meeting the gradation requirements of Article III, Item 15.4 shall be placed such that the material will be slightly above the underside of the pipe after compaction and to a minimum depth of six inches under the concrete pipe.
- (2) After the concrete pipe has been laid and the joints sealed, sand meeting the gradation requirements of Article III, Item 15.3 shall be placed under the haunches of the pipe and on the sides of the pipe, in lifts not to exceed 12 inches in depth. The sand shall be placed equally on both sides of the pipe in order that the pipe will not be displaced and, if necessary, the pipe shall be blocked against the sides of the trench to ensure that no displacement occurs. The sand placed under the haunches of the pipe shall be worked into place by hand during the time it is deposited into the trench. After the sand has been placed adjacent to the pipe in 12-inch lifts, the lifts shall be mechanically compacted. The remainder of the trench shall be backfilled with sand meeting the

gradation requirements of Article III, Item 15.3. When the distance to the edge of the trench nearest to the existing or proposed edge of pavement or back of curb is greater than three feet, the trench may be backfilled to the top of the trench with native material after the sand backfill has been placed to a level 12 inches above the top of pipe. The native material shall be free of clods and organic material such as roots or tree branches. All embedment and backfill shall be placed in a maximum of 12-inch lifts and mechanically compacted to obtain a density not less than 95 percent of the Standard Proctor Density for sand or gravel and 90 percent of the Standard Proctor Density for native material. The embedment and backfill is to be wetted to approximately optimum moisture content. Additional lifts shall not be placed until the lift being compacted has obtained a density of at least 95 percent of the Standard Proctor Density for sand and 90 percent of the Standard Proctor Density for native material. The contractor shall furnish necessary water.

7.10. *Concrete box culvert, manholes and inlets:*

7.10.1. *Description:* The work as herein prescribed shall consist of the furnishing of all materials and construction in accordance with the detailed drawings, for the box culvert, manholes, and inlets as shown on the plans or established by the engineer, including excavation and backfill, concrete, reinforcing steel, castings, fittings, and storm drain connections, complete in place.

7.10.2. *Materials:* All materials shall comply with Item 3, Concrete and reinforcing steel (structures).

7.10.3. *Construction:* All construction of culvert manholes and inlets shall comply with Item 3, Concrete and reinforcing steel (structures).

Backfilling for box culvert and wing walls shall consist of pit-run sandy gravel for a distance of approximately two feet in back of walls and suitable excavated materials for the remainder of the backfill compacted by hand or jetting to not less than 90 percent Standard Proctor Density. The compaction shall not be accomplished until the concrete has attained 28-day strength. Inlets and manholes within the proposed pavement width shall be backfilled with pit-run sandy gravel as specified under storm drains.

(Ord. No. 87-62, § 1, 9-15-87; Ord. No. 88-12, § 2, 2-2-88; Ord. No. 89-57, § 2, 9-5-89)

Item 8. Street name signs.

8.1. *Description:*

Street name signs shall be installed at locations shown on the plans and in accordance with the specification requirements contained herein. A street name sign shall be provided for each individual street at the location specified. Where two or more name signs are required at the same location a common street post may be used.

8.2. *Street name signs:*

Street name signs shall be made of aluminum having a minimum thickness of

0.072 inch. The signs shall be six inches in height and 18 inches, 24 inches, 30 inches or 36 inches in length depending upon the number of letters in the street name. The following information shall be set forth on the sign:

Direction	of	street
Name	of	street
Type	of	street (street, boulevard, avenue, etc.)
Block address number		

Street signs shall have medium green background with white letters and be approved by the street superintendent. Locations shall be as specified by the street superintendent.

8.3. *Street post and cap:*

The street post shall consist of a post and cap. The post shall be 2 3/8 inches in diameter and have a minimum wall thickness of 0.072 inch thickness and shall be of galvanized tubing. The post shall be a minimum of ten feet. The post shall be installed in a bored hole having a minimum diameter of 18 inches and a minimum depth of 2 1/2 feet. The post shall be embedded in 2,500 pounds per square inch concrete in the bored hole.

The street post cap shall consist of a cap 2 1/2 inches in diameter and shall be made of aluminum having a minimum thickness of 0.072 inches. The cap shall have a slot four inches in length, 1 1/16 inches in height and shall be furnished with two self-locking bolts.

8.4. *Street sign bracket:*

The street sign bracket shall be of aluminum having slots four inches in length, 1 1/16 inches in height and shall have four self-locking bolts.

Item 9. City standards.

9.1. *General:* At intervals, the city engineer's office will have drawings showing construction standards that are to apply for details of curb and gutters, drainage structures, street details, etc. Construction shall conform to the construction standards, as applicable, unless written approval is granted by the city engineer for variations.

9.2. *Availability of standards:* Planners may obtain copies of city design standards at same costs that reproduction firms use at that particular time. Copies of city standards may be direct prints or reproducible copies on sheets 22 inches by 36 inches.

Item 10. Street light standards.

10.1 *Materials.* All street light standards placed in subdivisions approved by the city council after September 24, 1985 shall be constructed of steel, in accordance with the regulations promulgated by Texas Utilities Electric Company. Such regulations shall be subject to approval by the city council of the City of Grapevine.

10.2 *Installations* All street light standards shall be supplied and installed by Texas Utilities Electric Company.

(Ord. No. 85-59, § 2, 9-24-85; Ord. No. 85-69, § 1, 11-5-85)

GRAPHIC LINK: typical section-asphaltic concrete, etc.

ARTICLE III. STANDARD SPECIFICATIONS FOR CONSTRUCTION--WATER DISTRIBUTION SYSTEM AND SANITARY SEWER SYSTEM

Item 1. General requirements.

1.1. Materials:

These specifications are intended to be so written that only materials of the best quality and grade will be furnished. The fact that the specifications may fail to be sufficiently complete in some detail will not relieve the contractor of full responsibility for providing materials of high quality and protecting them adequately until incorporation in the project. The specifications for materials set out the minimum standard of quality which the City of Grapevine believes necessary to procure a satisfactory project. No substitutions will be permitted until the contractor has received written permission of the city to make a substitution for the material which has been specified.

Where the term "or approved equal" is used, it is understood that if a material, product or piece of equipment of the specified name and quality is furnished it will be approvable, as the particular trade name and quality was used for the purpose of establishing a standard of quality acceptable to the city. If a product of any other name is proposed for use, the engineer's approval thereof must be obtained before the proposed substitute is procured by the contractor. Wherever the term "or equal" is used, it is understood to mean "or approved equal."

Where the terms "or approved equal" or "or equal" are not used, the contractor shall furnish the material as specified and no substitutions will be allowed. Where the term "owner" appears herein, it shall be assumed to be the City of Grapevine, Texas.

1.2. Workmanship: These specifications contain detail instructions and descriptions covering the major items of construction and workmanship necessary for building and completing the various units or elements of the project. The specifications are intended to be so written that only first class workmanship and finish of the best grade and quality will result. The fact that these specifications may fail to be so complete as to cover all details will not relieve the contractor of full responsibility for providing a completed project of high quality, first class finish and appearance, and satisfactory for operation, all within the apparent intent of the plans and specifications.

1.3. Handling materials not approved: The contractor shall remove from the site any materials found to be damaged, and any materials not meeting the specifications. These materials shall be removed promptly, unless the engineer will accept the materials after repairing. Materials found to be damaged, or not acceptable to the engineer, shall be removed if installed and then found to be damaged or not acceptable. Inspection before installation shall not relieve the contractor from any responsibility to furnish good quality materials.

1.4. Clearing and grubbing: The contractor shall do all clearing and grubbing necessary for construction operations. All trees, branches, limbs, and roots shall be removed and disposed of by the contractor so as to leave the right-of-way in a neat and presentable condition. Clearing and grubbing shall be done so as not to injure or

damage adjacent property. In disposing of brush, particular care shall be taken so as to eliminate the possibility of starting a grass fire. Any and all damages outside the limits of the construction right-of-way shall be paid for and settled by the contractor at his expense.

1.5. *Safety and property protection:*

1.5.1. *Traffic control in work areas, barricades, guards and safety provisions:* To protect persons from injury and to avoid property damage, adequate barricades, construction signs, guards, and other traffic controls as required shall be placed along all roads, street crossings, etc., and shall be maintained during the progress of the construction work and until it is safe for traffic to use the construction site. The contractor shall comply with the requirements of the 1973 Texas Manual on Uniform Traffic Control Devices. A copy of the manual may be examined at the city hall. Excavations for construction operations shall be conducted in a manner to cause the least interruption of traffic. Where traffic must cross open trenches, the contractor shall provide suitable bridges at road crossings, street intersections and driveways.

1.5.2. *Flow of drains and sewers maintained:* Adequate provisions shall be made for the flow of storm sewers, drains and watercourses encountered during the construction and the structures which may have been disturbed shall be satisfactorily restored upon completion of the work.

1.5.3. *Property protection:* Trees, fences, signs, poles, guy wires, and all other property shall be protected unless their removal is authorized, and any property damage shall be satisfactorily restored by the contractor. The contractor shall make adequate provision for the protection of permanent paving, both concrete and asphalt, from damage by construction equipment.

1.6. *Guarantee:* The contractor shall guarantee the work for a period of two years after the date of acceptance by the city. During this two year period, the contractor shall make any repairs and/or replacement of defective materials and corrections due to poor workmanship, all as may be required for full compliance with the specifications. This guarantee shall apply to all matters reported by the city in writing within said two year period, and this guarantee shall be backed by the issuance of a maintenance bond. Said maintenance bond shall be issued by a surety licensed to operate within the State of Texas, shall be for a time period of two years from the date of acceptance by the city, and shall be in an amount equal to 25 percent of the cost of construction of the work being guaranteed.

1.7. *Water for construction:* The contractor shall furnish all water required for construction. The contractor may purchase water from the city at published water rates. All connections to the city's water system shall meet the approval of the city. The contractor shall post a deposit with the city to use a city construction meter.

1.8. *Disposal of excess material:* The contractor shall dispose of all excess material at his expense.

1.9. *Maintenance and cleanup:* During the prosecution of the work, the contractor shall maintain the project site in an orderly and acceptable manner. Upon completion of any unit of work, it shall be maintained by the contractor until acceptance by the city of

the entire work covered by this contract. Upon completion, as a whole of the project, the contractor shall clean and remove from the site of the project surplus and discarded materials, temporary structures, and debris of every kind; and shall leave the site of the work in a neat and orderly condition.

1.10. *Sanitary sewer lines near water lines:* In such cases where water lines either cross or otherwise come within nine feet of a sanitary sewer line, then a special construction method shall be applied to the sewer pipe so that the sewer pipe will be a pressure pipe at all locations where the water pipe and sewer pipe are less than nine feet apart. The sewer pipe in such cases may be either cast-iron or PVC, C-900, with a minimum working pressure class of 150 pounds per square inch.

1.11. *Locations of water and sewer mains:* In general, water and sewer mains shall be placed within street rights-of-way. Local conditions may require variations from locations in streets, especially for sewer mains and/or laterals. In general, water mains shall be located with the center line 3 1/2 feet back of curbs on the north side of east-west streets and on the east side of north-south streets. Sewer mains and laterals parallel to water mains shall be placed in streets half-way between street center line and back of curb opposite the water mains. Variations from these locations shall have written approval of city engineer.

1.12. *Permit for construction:* A permit issued by the public works department shall be secured by the contractor prior to start of construction.

(Ord. No. 87-65, § 2, 10-6-87; Ord. No. 88-64, § 2, 9-20-88)

Item 2. Excavation, backfill and pipe embedment.

2.1. Trench width:

The maximum allowable trench width in the pipe zone shall be O.D. of the pipe plus 24 inches, and the minimum allowable trench width in the pipe zone shall be O.D. of the pipe plus 12 inches. The trench walls shall be substantially vertical in the pipe zone. The pipe zone shall be considered as the vertical distance from the bottom of the trench to an elevation one foot above the top of pipe when the pipe is at the specified grade.

Trench widths above pipe zones shall be kept within reasonable and safe widths. The contractor shall be responsible for keeping trench widths within bounds of the easements and/or street rights-of-way, using measures to keep widths within reasonable and safe conditions. The contractor shall be fully responsible for damages outside easements and structures within streets or easements.

2.2. Depth and alignment control:

For sewer and designated water lines, grade hubs will be set by the engineer at intervals of 100 feet, and the contractor will be furnished with a cut sheet showing the difference in elevation between the hub and the flow line of the pipe. The grade hub will be offset from center line a convenient distance, which distance is mutually agreeable to the contractor and the engineer. The contractor shall conduct his operations in such a manner as not to destroy the stakes until the pipe has been laid and checked for alignment and grade. Grade stakes will be set at a convenient distance from the center line of pipe which will permit such leveling up operations as necessary ahead of ditching without disturbing the

grade stakes. All the grade stakes will be set within a short period of time near the beginning of the job.

Sewer lines shall be laid to grade and alignment using laser instrument that is in good operable condition. The laser equipment shall be operated by qualified personnel using grade stakes for check on elevations. Better boards shall not be used without the engineer's approval for sewer lines.

Water lines, where laying to grade is required, may be laid using better boards, and/or grade stakes set by the engineer, for construction. In general, water lines shall be laid so as to have minimum cover of three feet after finish grading is performed. Water lines designated to set to grade shall be at elevations shown on plans.

2.3. Sheet piling and bracing: This contractor shall furnish and install such sheet piling, bracing, and/or trench jacks as may be necessary to ensure safe working conditions for personnel required to work in the bottom of the trench. It is not the desire of the city or the engineer to assume the responsibility of deciding what conditions are safe and what conditions are unsafe. The contractor is expected to exercise good judgment and due caution in regard to the safety of his personnel.

All trenches that are required to be excavated to a depth in excess of five feet shall be excavated and maintained in a manner that meets all Occupational Safety and Health Administration standards. The contractor shall provide the city, prior to excavation and construction of the trench(es), with detailed plans and specifications for record, certified by a registered professional engineer, that provide for adequate safety systems that meet the Occupational Safety and Health Administration standards. The detailed plans and specifications shall include requirements for a safety program for the trench system.

2.4. Dewatering: This contractor shall be responsible for the proper handling of water from any source which may find its way into the trench or excavations. Any water in the trench where pipe is being laid must be disposed of in a satisfactory manner so that pipe laying may be done in the dry. Also, concrete work must be done in the dry which will require that such water as may occur in any excavation such as the manholes shall be removed.

2.5. Bottom trench grading: Trenches shall be excavated to depths as required for the laying of pipe to the grades shown on the plans. Excavation shall be carried to the depth below profile grade as necessary to permit the installation of embedment material required for the pipe.

2.6. Excavation for structures: Care shall be exercised in excavating for the floor slabs of structures, and for the footings manholes. It will be required that these concrete footing and floors be poured on undisturbed earth. In the event that the contractor should over excavate below the planned footing or floor elevation, then such over excavation shall be filled in with concrete at the contractor's expense. Compacted backfill for filling over excavated areas will not be acceptable.

2.7. Embedment and backfill around pipe and structures:

Sanitary sewer pipe shall be embedded on a minimum of six inches of gravel meeting the gradation of Article III, Item 15.4. All waterlines shall be bedded on a minimum of six inches of sand meeting the gradation of Article III, Item 15.3. Backfill above the embedment shall be with full depth sand which complies with

the gradation set forth in Article III, Item 15.3. When the distance to the edge of the trench nearest to the edge of existing or proposed edge of pavement or back of curb is greater than three feet, and/or within an easement, the trench may be backfilled to the top of the trench with native material after the sand backfill has been placed to a level at least 12 inches above the top of pipe. The native material shall be free of clods and organic material such as roots or tree limbs. All embedment and backfill shall be wetted to approximate optimum moisture and compacted using mechanical methods in lifts not to exceed 12 inches and shall achieve a minimum density of 95 percent of the Standard Proctor Density for sand or gravel and 90 percent of the Standard Proctor Density for native material. Additional lifts shall not be placed until the lift being compacted has reached the required density.

2.8. Rock excavating:

Rock will be defined as any material encountered in trench, tunnel or manhole excavation which must be removed by use of air tools such as jackhammers or blasting. Material which cannot be dug with a backhoe of the 1 1/2 cubic yard class will generally fall into this category. Where there is some question as to whether a material is rock or not, the engineer's judgement will be final in regard to such classification.

No rock will be permitted in backfill in the pipe zone from bottom of trench to two feet above the pipe nor in the top 18 inches of trench backfill at the ground surface. Other than these two locations, rock may be placed in the backfill provided the size of pieces in the largest dimension does not exceed six inches. In such cases where the rock cannot be used in the backfill, then such rock shall be disposed of off the project site by this contractor.

Where blasting is required, the contractor shall secure a permit from the city for such blasting. The contractor shall exercise due caution and shall be responsible for any damage or claims resulting from the blasting. Mats, and/or other safety precautions shall be used as needed.

2.9. Maintenance of surface:

It will be this contractor's responsibility to maintain the trench backfill and working areas so as to present a smooth, uniform and neat appearance at all times until the final estimate has been issued. Where some trench settlement occurs after a rain, the area shall be rebladed and brought back to a smooth uniform condition.

Where the pipe trench crosses roadways or traverses a roadway shoulder, such areas shall be kept well maintained by this contractor until project acceptance and then through the guarantee period.

2.10. Television inspection:

Prior to acceptance of the sewer line installation by the city, a television camera shall be pulled through the line to inspect for unacceptable taps, joints, or low sections. The line shall be thoroughly flushed immediately prior to insertion of the camera. All deficiencies shall be corrected by the contractor and reinspected. The city's camera will be made available with one week's notice so that a crew can be scheduled to perform the work. The contractor shall reimburse the city for all labor costs involved, prior to acceptance of the work.

(Ord. No. 87-62, § 2, 9-15-87; Ord. No. 88-12, §§ 3, 4, 2-2-88; Ord. No. 89-57, §§ 3, 4, 9-5-89)

Item 3. Concrete and reinforcing steel (structures).

3.1. General:

Concrete shall be composed of portland cement, fine aggregate, coarse aggregate, water and a water-dispersing agent properly proportioned and mixed as hereinafter specified. All structural concrete shall be class 3,000 pounds per square inch, minimum compressive strength at 28 days, unless otherwise shown on the plans.

3.2. Materials:

Portland cement shall conform to the specifications and tests for Type I portland cement of the American Society for Testing Materials, Serial Designation C-150.

Fine aggregate shall conform to the Standard Specification for Concrete Aggregate, American Society for Testing Materials Designation C-33. In addition to the requirements of the American Society for Testing Materials specifications, the fine aggregate shall also conform to the following:

1. Loss shall not exceed ten percent by weight in five cycles when tested for soundness in accordance with American Society for Testing Materials Method of Test Designation C-88, except as noted American Society for Testing Materials Specification Designation C-33.
2. The amount of deleterious substances shall not exceed recommended permissible limits as set forth in American Society for Testing Materials Specification Designation C-33, and other deleterious substances will not be allowed.
3. The mortar, for test of fine aggregate, made and tested in accordance with Standard Method of Test for Measuring Mortar-Making Properties of Fine Aggregate, American Society for Testing Materials Designation C-87, shall develop a comprehensive strength at seven and 28 days of not less than 100 percent of that developed by the mortar specified in that method as the basis of compensation.

Coarse aggregate shall conform to the Standard Specifications for Concrete Aggregates, American Society for Testing Materials Designation C-33. In addition to the requirements of the American Society for Testing Materials specifications, the coarse aggregate shall also conform to the following:

1. Wear shall not exceed 40 percent when tested according to American Society for Testing Materials Standard Method for Abrasion of Coarse Aggregates by Use of the Los Angeles Machine, Designation C-131.
2. Loss shall not exceed 13 percent by weight in five cycles when tested for soundness in accordance with American Society for Testing Materials Method of Test Designation C-88, except as noted in American Society for Testing Materials Specification Designation C-33.
3. The amount of deleterious substances shall not exceed recommended

permissible limits as set forth in American Society for Testing Materials Specification Designation C-33, and other deleterious substances will not be allowed.

For the contractor's convenience, the American Society for Testing Materials grading requirements applicable to this project are listed hereinafter:

Fine Aggregate

TABLE INSET:

<i>Sieve Size</i>	<i>% Passing</i>
<i>3/8 inch</i>	<i>100</i>
<i>No. 4</i>	<i>95--100</i>
<i>No. 8</i>	<i>80--100</i>
<i>No. 16</i>	<i>50--85</i>
<i>No. 30</i>	<i>10--60</i>
<i>No. 50</i>	<i>10--30</i>
<i>No. 100</i>	<i>2--10</i>

Coarse Aggregate

TABLE INSET:

<i>Sieve Size Sq. Openings</i>	<i>% passing</i>
<i>2 inches</i>	<i>100</i>
<i>1 1/2 inches</i>	<i>95--100</i>
<i>3/4 inch</i>	<i>35--70</i>
<i>3/8 inch</i>	<i>10--30</i>
<i>No. 4</i>	<i>0--5</i>

Water for concrete shall be clean and free from oil, acid, alkali, organic matter, or other harmful impurities. Water which is suitable for drinking or for ordinary household use will be acceptable for concrete. Where available, water shall be obtained from mains or a waterworks system._____

3.3. *Concrete proportions and consistency:* Concrete shall be proportioned to give the necessary workability and strength and shall conform to the following governing requirements:

TABLE INSET:

<i>Min. 28-day compressive strength</i>	<i>Min. cement bags per cubic yard</i>	<i>Max. size of coarse aggregate in inches</i>	<i>Max. water gals. per bag</i>	<i>Slump inches</i>
<i>3000</i>	<i>.5</i>	<i>1/2</i>	<i>.75</i>	<i>--6</i>
<i>2000</i>	<i>.0</i>	<i>1/2</i>	<i>.00</i>	<i>--6</i>
<i>1500 (cradle)</i>	<i>.0</i>	<i>1/2</i>	<i>.00</i>	<i>--4</i>
<i>Stabilized backfill</i>	<i>.0</i>	<i>*</i>	<i>.00</i>	<i>--4</i>

* May be pit run aggregate.

The proportion of fine and coarse aggregate shall be such that the requirements

of the following table are complied with:

TABLE INSET:

<i>Maximum size of coarse aggregate in inches</i>	<i>Ratio of coarse aggregate to fine aggregate on basis of dry and rodded volumes</i>	
	<i>Minimum</i>	<i>Maximum</i>
<i>3/4</i>	<i>.6</i>	<i>.5</i>
<i>1 and over</i>	<i>.0</i>	<i>.0</i>

In no case shall the amount of coarse material be such to produce harshness in placing and honeycombing in the structure when forms are removed.

In the determination of the amount of water required for mix, consideration shall be given to the moisture content of the aggregate. The net amount of water in the mix will be the amount added at the mixer; plus the free water in the aggregate; and minus the absorption of the aggregate, based on 30 minutes absorption period. No water allowance will be made for evaporation after batching.

The methods of measure of materials shall be such that the proportions of water to cement can be closely controlled during the progress of the work and easily checked at any time by the engineer or his representative. To avoid unnecessary or haphazard changes in consistency, the aggregates shall be obtained from a source which will ensure uniform quality and grading during any single day's operation and they shall be delivered to the work and handled in such manner that the variations in moisture content will not interfere with the steady production of concrete of reasonable degree of uniformity. All sources of supply shall be approved by the engineer.

All materials shall be separately and accurately measured. Measurement may be made by weight or by volume, as may be elected by the contractor; however, all equipment for measurement of materials shall be subject to approval by the engineer.

The proportions of the mix shall be such as to produce concrete that can be puddled readily into the corners and angles of the forms and around the reinforcing without excessive spading, and without segregation or undue accumulation of water or laitance on the surface.

3.4. *Trial mixes:*

The contractor shall furnish the engineer with the concrete mix design and laboratory test data for the actual design to be used well ahead of any concrete placement. The concrete supplier shall so designate the particular mix design that it can be identified by records that are kept by the supplier and delivery tickets shall show such mix design. The contractor shall furnish the engineer with copies of delivery tickets showing mix designation.

For concrete other than manholes, blocking cradle or structures requiring more than a total of ten cubic yards, at least 35 days prior to the beginning of concrete placing, the contractor shall submit samples of materials he proposes to use and a statement of proportions proposed for several concrete mixes, having sufficient range in slump to cover all placing conditions.

The engineer will require that laboratory tests be made and such changes as

may be necessary to meet the requirements of the specifications. Laboratory tests on trial mixes shall show a 28-day strength 15 percent higher than the stated minimum 28-day strength. From these preliminary tests, the ratios between seven-day and 28-day strengths shall be established to determine at seven days the strength necessary to satisfy the required 28-day strengths. These ratios shall be modified as the work progresses as indicated by result of tests on cylinders made from field mixed concepts.

If, during the progress of the work, it is found impossible to secure concrete of required workability and strength with the materials being furnished by the contractor, the engineer may order changes in proportions or materials, or both, necessary to secure the desired properties, subject to limitations already stated. The contractor shall not make changes in materials, either gradation, source, or brand, or proportions of the mixture after their having been approved except by specific approval of the engineer.

The contractor shall have the preliminary testing done by an approved testing laboratory, and shall pay for all preliminary tests on aggregates and test cylinders.

If contractor can provide mix design and satisfactory test cylinder record from a recent job using same materials, then the preliminary test requirement will be waived.

3.5. *Transit mix concrete:* Transit mix concrete will be permitted in lieu of mixing on the job, provided all of the following conditions are complied with:

- (1) All requirements otherwise specified for mixing on the job shall apply.
- (2) Sufficient transit mix equipment shall be assigned exclusively to the project as required for continuous pours.
- (3) Satisfactory evidences shall be furnished that the delivery of concrete shall be continuous at regular and uniform intervals without stoppages or interruptions.
- (4) All concrete shall be deposited in the forms within 45 minutes after water has been added to the mix. Concrete retained in the truck longer than 45 minutes after water has been added to the mix will be rejected.

3.6. *Testing and control of mix during construction:*

Sufficient test cylinders shall be made by laboratory personnel at intervals to determine compliance with the specifications. Test cylinders shall be made in groups of three for each compliance test, so that one cylinder can be tested at seven days, one tested at 28 days and the remaining cylinder is to be tested in event other tests are questionable. Test cylinders shall be made for each mix design and for each ten cubic yards of concrete placement; except where concrete is to be used for blocking, cradle or encasement, tests after compliance tests may be waived by the engineer. The compression tests of concrete cylinders shall be made by an independent testing laboratory approved by the city. The testing costs as described herein shall be paid for by the contractor; however, the city, at its own expense, reserves the right to have additional tests performed.

The control of proportioning and mixing of all ready mix, transit mix or central plant concrete shall be under the supervision of a trained representative of an established independent testing laboratory, which laboratory has been approved by the owner. The laboratory representative shall work in cooperation with the engineer, and shall furnish to the engineer as summary of all tests which are performed and for each concrete pour shall furnish a certificate of compliance with the specification. No concrete shall be poured without the laboratory representative being present at the batching plant. For concrete pours of ten cubic yards or less, the engineer may waive the requirements for a laboratory technician.

3.7. Forms:

Forms shall be built mortartight, and true to line and grade. Studs, walers, and approved form ties shall be used at the proper spacing and be of the proper size to maintain straight lines on all vertical surfaces. Forms for surfaces requiring a rub finish shall be lined with plywood, Masonite or other approved form lining.

Forms on vertical surfaces shall remain in place a minimum of six hours. Forms under horizontal surfaces shall remain in place seven days.

3.8. Placing concrete:

The contractor shall give the engineer at least 24 hours advance notice before starting to place concrete in any unit of the structure to permit the inspection of forms, the reinforcing steel placement, and preparation for pouring. Unless authorized by the engineer, no concrete shall be placed in any unit prior to the completion of the form work and placement of the reinforcement.

The sequence of placing concrete shall be as provided on the plans or the specifications. The operation of depositing and compacting the concrete shall be conducted so as to form a compact, dense, impervious mass of uniform texture which shall show smooth faces on all surfaces.

The placing shall be so regulated that the pressures caused by the plastic concrete shall not exceed the loads used in the design of forms.

Careful attention shall be given by the contractor to the proper curing of all concrete.

3.9. Freezing weather:

When depositing concrete at or near freezing temperatures, the concrete shall have a temperature of at least 50 degrees Fahrenheit, but not more than 120 degrees Fahrenheit, when aggregates are heated. The concrete shall be maintained at a temperature of at least 50 degrees thoroughly hardened. When necessary, concrete materials shall be heated before mixing and heating apparatus such as stoves, salamander, etc., shall be supplied to maintain the concrete at the required temperature. The contractor shall be responsible for the protection of concrete placed under any and all weather conditions.

No concrete shall be poured on frozen or thawing subgrade or during unfavorable weather conditions. No concrete shall be placed when the temperature is 40 degrees Fahrenheit and falling; however, concrete may be placed when the temperature is 35 degrees Fahrenheit, minimum, and rising.

3.10. *Curing:* All concrete shall be cured by keeping continuously wet for seven days after pouring. On surfaces which do not require a rubbed finish, the concrete may be cured by supplying a curing compound in lieu of water curing if the contractor so desires. Curing compound shall be Hunts Process or approved equal applied as closely behind concrete finishing as possible.

3.11. *Rub-finished exposed surfaces:*

The following exposed vertical concrete surface shall be given a rubbed finish: The exposed vertical surfaces to a point one foot below the final ground line.

The rubbing operation shall be in accordance with the following provisions: As soon as forms are removed, all necessary painting shall be done. When the painting has set sufficiently to permit it, all surfaces requiring surface finish shall be wet with a brush and given a first surface rubbing with a No. 16 carborundum stone or an abrasive of equal quality. The rate of removal of forms shall be determined by the rate of the complete rubbing. The rubbing shall be continued sufficiently to bring the surface to a paste, to remove all forms marks and projections, and to produce a smooth dense surface without pits or irregularities. The use of cement to form a surface paste will not be permitted. The material which has been ground to a paste in this process shall be carefully spread or brushed uniformly over the surface and allowed to reset. In general, chamfered corners shall not be rubbed in the first surface rubbing. During the process of conditioning the completed structure for final acceptance, the surfaces of the entire structure requiring finish shall be cleaned free from drip marks and discolorations and shall be given a final finish rubbing with a No. 30 carborundum stone or an abrasive of equal quality. On completion of this rubbing, the surface shall be neatly stripped with a brush and mortar on the surface and shall be allowed to reset. The surface shall then be washed down with clean water. The entire structure shall be left with a clean, neat and uniform appearing finish and shall be uniform in color.

3.12. *Reinforcing steel:* Reinforcing steel shall be billet steel, intermediate grade, deformed bars, conforming to American Society for Testing Materials Specification A-15, or shall be rail steel, deformed bars conforming to American Society for Testing Materials Specification A-16. All mill scale shall be removed before placing and bars shall be kept clean until concrete is placed. The steel shall be placed in the forms as shown on the plans and shall be maintained in place by wiring or by any other effective means approved by the engineer.

Item 4. Cast-iron pipe and fittings.

4.1. *General:*

This section covers the furnishings of all cast-iron pipe and fittings. The plans show the sizes and general arrangement of all pipes and fittings; however, the responsibility for furnishing exact lengths of the various pipes for proper make-up and for providing special items as may be required to simplify or facilitate the installation rests with the contractor. Cast-iron pressure pipe shall be new, manufactured in the United States of America and acceptable to the State Fire Insurance Commission of Texas and Underwriters' Laboratories approved.

Cast-iron pipe shall be ductile cast iron meeting the requirements herein

specified. Gray cast-iron pipe shall not be furnished and installed without written approval by the owner. Pipe of same size, for each run, shall be same type metal.

The pressure rating, type metal, metal thickness, class, net weight of pipe without lining, length of pipe and name of manufacturer shall be clearly marked on each length of pipe.

Pipe shall be mechanical joint, Fastite, Bell-Tite or TYTON, or flanged as required.

Mechanical joint pipe shall be in accordance with American National Standards Institute Specification A21.11 and furnished with complete mechanical joint accessories. The bolts and nuts shall be high strength, corrosion-resistant alloy with tee-head and hexagon nut.

4.2. Gray cast-iron pipe:

Pipe shall be designed in accordance with American Water Works Association Specification C101 (American National Standards Institute Specification A21.1) method of design using 21,000 pounds per square inch bursting tensile and 45,000 pounds per square inch modulus of rupture. Pipe shall be a minimum of Class 150 designed for 150 pounds per square inch water pressure, five feet cover, trench condition B, flat bottom, no blocks, tamped backfilled and at least 85 pounds per square inch water hammer allowance and 2 1/2 to 1 safety factor.

Pipe is to be manufactured in accordance with American Water Works Association Specification C106-75 (metal molds) or C108-75 (sand-lined molds) except minimum bursting tensile of 21,000 pounds per square inch, minimum modulus of rupture of 45,000 pounds per square inch, and maximum modulus of elasticity of 10,000 pounds per square inch.

All flanged end pipe shall conform to either American Water Works Association Specification C106 for physical and chemical requirements for pipe barrel and American National Standards Institute Specification A21.10 for flanges. Flanged fittings shall conform to either American Water Works Association Specification C110 or American National Standards Institute 21.10 or American National Standards Institute Specification B16.1. Flanges shall be Class 125 for all pipe, fittings, and valves, unless otherwise shown or specified.

Gray cast-iron pipe shall be minimum class thickness meeting requirements of American National Standards Institute Specification A21.1 for five feet cover and laying condition B.

4.3. Ductile iron pipe:

Ductile iron pipe shall meet requirements of American Water Works Association Specification C151 and/or American National Standards Institute Specification A21.51. Pipe wall thickness shall be determined in accordance with American Water Works Association Manual H3 or American National Standards Institute Specification A21.50. Pipe shall be designed for not less than 150 pounds per square inch working pressure with 100 pounds per square inch surge, eight-foot cover, trench and truck loads. Joints may be as shown above.

Ductile iron fittings shall meet requirements of American Water Works

Association Specification C110 or American National Standards Institute A21.10 for not less than 150 pounds per square inch working pressure.

4.4. Lining and coating:

Pipe and fittings shall be lined with an approved thin cement lining sealed with an approved bituminous seal coat in accordance with ASA Specification A21.4 wherever applicable; and as further specified herein. Thickness of cement lining shall not be less than one-half thickness specified under Section 4-10 of the ASA Specification.

Outside coating shall be coal tar pitch varnish, to which sufficient oil shall be added to make a smooth coating, tough and tenacious when cold, not tacky and not brittle.

4.5. Gaskets: Gaskets for flanged joints shall be full face type, natural red rubber, 1 1/16 inch thick. Gaskets for push-on or mechanical joints shall be rubber suitable for both water and sanitary sewage.

Item 5. Installing cast-iron pipe and fittings.

5.1. Description:

Cast-iron pipe, fittings, specials and valves are to be installed at locations shown on the plans and specified in these contract documents.

If a profile grade is indicated on the plans, the pipe shall be laid accordingly. Where a profile grade is not shown, the pipe shall be laid to an even grade from point to point avoiding minor high points that would tend to form air traps. Normally the pipe will be laid with approximately three feet of cover. Where pipe is to be laid behind a future curb, the cover may exceed three feet, and will be laid to follow the curb grade. Trench depth information will be furnished where this condition occurs.

All of the requirements of the specifications under the section Embedment for pipe, excavation and backfill, and Backfilling of trenches under pavement and/or within highway right-of-way, govern for laying cast-iron pipe, fittings and specials.

5.2. Pipe handling:

All pipe, fittings, special castings and gate valves shall be lowered into trench by derrick, tripod, crane or other suitable machine and shall not be rolled in or dumped into the trench. Pipe fittings and valves shall be handled in such a manner as not to damage the coating. Before lowering and while suspended, each piece of pipe shall be rung with a light hammer to detect flaws, and any unsound pipe shall be rejected. All dirt and trash that may be in the barrel of the pipe, on the spigot and/or in the bell shall be removed while the pipe is suspended. All pipe and fittings shall be handled and lowered into the trench with slings. The use of hooks for handling pipe and fittings will not be permitted.

Where it becomes necessary to deflect the pipe to avoid obstructions, the deflection of each joint must be approved by the engineer.

The pipe is to be kept clean during the laying operation and free of all sticks, dirt and trash, and at the close of each operating day the open end of the pipe is to

be effectively sealed against the entrance of all objects and especially water.

Unless otherwise specified or unless otherwise directed by the engineer, the joints for all bell and spigot cast-iron pipe, fittings and specials shall be made, using lead and/or mechanical joint for jointing materials and/or Tyton Joint (or similar joint).

5.3. *Joint making:*

5.3.1. *Jointing mechanical joint pipe:*

This type pipe shall be jointed in full accordance with the manufacturer's recommendations and shall be done in a neat and workmanlike manner. Care shall be taken to prevent shearing the bolts.

The jointing of the pipe shall be done as follows, unless otherwise directed by the engineer.

- a. After carefully cleaning both spigot and bell and after slipping the follower ring and gasket over the spigot end, the spigot shall be slipped into the bell.
- b. If requested by the engineer, a lubricant shall be applied to the spigot to assist in assembly.
- c. The gasket shall be carefully seated by hand so as to be even in the bell at all points.
- d. After drawing up the follower ring to uniform bearing against the gasket, the bolts are to be inserted and tightened by hand in pairs using bolts opposite each other.
- e. The nuts are to be tightened amply to hold the required pressure. Extension wrenches, or pipes over wrench handles, will not be permitted. Ten-inch ratchet wrenches shall be used to tighten the nuts, unless other type wrenches are approved by the engineer.
- f. Sand cast "T" bolts shall not be acceptable.

The finished joints shall be neat and uniform and shall be watertight.

5.3.2. *Making flanged joints:* The contractor shall be responsible for the measurement of all connections. Flanged piping shall be erected in accordance with the controlling dimension shown on the plans. Each piece of flanged pipe shall be thoroughly cleaned to remove dirt, rust, grease, and other foreign matter, and flanged faces shall be thoroughly wire brushed to ensure even bearing for gaskets and mating flanges. Gaskets for flanged joints shall be composition sheet-packing, full faced, factory cut, of 1/16 inch thickness, red rubber, Cranite, or approved equal. Flange bolts shall be installed with bolts in one direction. Flange bolts shall be tightened, each in turn, at a uniform rate around the joint.

5.3.3. *Making push-on joints:* The jointing of this type of joint shall be as recommended by the manufacturer. The procedure for jointing shall be generally as follows:

- a. The spigot and socket shall be thoroughly cleaned and dried

before starting the assembly of the joint. The gasket seat in the socket and the gasket shall be wiped with a cloth.

- b. A thin film of lubricant shall be applied to the inside surface of the gasket that will come in contact with the entering pipe spigot.
- c. The spigot shall have a film of lubricant, if necessary.
- d. The joint shall be made by exerting sufficient force on the entering pipe so that its plain end will move past the gasket. This exerting force may be by use of the crowbar method, (eight inches and smaller); fork-tool method, (eight inches and smaller); jack method, (ten inches and larger).

5.4. *Concrete blocking of pipe and fittings:* Concrete blocking shall be placed at all bends, tees, crosses, plugs, fire hydrants, etc. The concrete shall have a 28-day compressive strength of not less than 2,000 pounds per square inch and shall be as specified under Item 3. The blocking shall be placed to rest against firm undisturbed trench walls. The support area for each block shall be sufficient to withstand the thrust, including water hammer. The area required will be computed based on 150 pounds per square inch working pressure plus 30 pounds per square inch allowance for water hammer. The support valve of the soil is estimated to be 2,000 pounds per square inch trench bottom. Concrete shall be installed in such a manner not to interfere with other repairing of the joint.

Item 6. Concrete pressure pipe.

6.1. *General:* This specification includes materials, fabrication and delivery for concrete cylinder pipe and specials of the various sizes and classes as shown in the proposal and on the plans. All concrete cylinder pipe shall be manufactured in accordance with the requirements of American Water Works Association Standard C-303-78, entitled "Reinforced Concrete Water Pipe--Steel Cylinder Type, Pretensioned," or American Water Works Association Standard C-301-72, entitled "Prestressed Concrete Pressure Pipe--Steel Cylinder Type for Water and Other Liquids," with additional requirements and/or modifications as described herein.

6.2. *Pipe classes:* The sizes and design pressure classes shall be as shown in the proposal. Fittings, specials and connections shall be of a class not less than the associated pipe. Minimum classes shall be 150.

6.3. *Special requirements:*

6.3.1. *Cement:* Cement for use on inside and outside mortar coatings shall be Type II Portland cement, with not more than five percent tricalcium aluminate (C₃A). Mortar strength for both linings and coastings shall be not less than 4,500 pounds per square inch after 28 days, as determined by compression tests on two-inch by two-inch cubes.

6.3.2. *Bell rings:* Bell rings shall be as shown in American Water Works Association Specification C-303; except, thickness shall not be less than 3/16 inch.

6.3.3. *Flanges:*

Flanges shall have American standard drilling of class equal to or greater

than the pipe class, unless otherwise specified, and shall match class of valves or appurtenances which are attached. Flange gaskets shall be 1/16-inch thick red rubber, full faced.

Valves to be installed in concrete cylinder pipe runs shall have flanged ends, drilled as per American National Standards Institute No. 125, unless otherwise shown on plans. Where main line valves are to be installed in runs of rubber gasket pipe, the contractor shall furnish and install short adapter with ends flange to rubber gasket, C-303 joint. Joints for connecting to valves shall be insulated type for protection against electrolysis.

- 6.3.4. *Curing:* The pipe shall be cured by steam curing (hot water vapor) at a temperature of 100 degrees Fahrenheit to 150 degrees Fahrenheit. The pipe lining shall be steam cured for not less than 12 hours before placing helically wound reinforcement. The complete pipe shall be steam cured for an additional period of not less than 36 hours or water cured for a period of not less than 144 hours (six days). Water curing is not acceptable if exposed to temperatures below 40 degrees Fahrenheit during curing period.

6.3.5. *Insulated connection:*

The contractor shall furnish insulation gaskets and/or bushings at all points where external valves, pipe, or fittings are connected to the line.

Where outlets or taps, are threaded, the contractor shall furnish and install bushings similar or equal to MayCo Dielectric Bushings as made by the May Company, Galesburg, Illinois. Where flanged outlets are to be insulated the contractor shall furnish Insulket flange gaskets, insulating sleeves and two plastic washers for each bolt, as supplied by Texas Plastics Materials Supply Co., Fort Worth, Texas.

- 6.3.6. *Specials:* Bends for deflections shall be provided as necessary for installation to the profile shown on the plans. Where deflections do not exceed five degrees, the spigot end of pipe may be installed on mitered ends of pipe. Bends shall be furnished and installed for deflections greater than five degrees.

- 6.3.7. *Coating and lining:* The cement mortar lining inside the steel cylinders and the mortar coating on the exterior of the pipe shall be not less than that specified in applicable specifications. Where pipe is to be installed in castings, the contractor shall furnish pipe with built-up bands of mortar coating that are to be of a slightly larger diameter than the pipe bells. The built-up bands shall be about two feet long and shall have centers about center and one-fourth pipe length from each end.

6.3.8. *Inspection and test procedures:*

All welds on fittings and specials with deflection greater than five degrees shall be tested and the test shall be witnessed by an independent testing laboratory, if such laboratory has been selected and retained by the city. Representatives of the laboratory and the engineer shall have access to the work wherever it is in preparation or progress, and the pipe manufacturer shall provide proper facilities for access and for inspection.

Material, fabricated parts, and fittings which are discovered to be defective, or which do not conform to the requirements of this specification will be subject to rejection at any time prior to final acceptance.

All welds for watertightness in special pipe and fittings that have not been hydrostatically tested may be examined by use of visible dye penetrant system meeting requirements of American Society for Testing Materials Specification E165; however, collar reinforcement and all other lap-welds shall be tested by introducing air under ten pounds per square inch pressure between the collar and cylinder and checking for leaks around and through the welds with soap solution. The city reserves the right to require testing of welds for designated specials and/or fittings by use of air under ten pounds per square inch pressure, if the owner's representative is not satisfied with the dye penetrant method of testing for watertightness.

The area to receive the dye penetrant shall be cleaned free from contaminants that might interfere with the penetrant process. The temperature of the steel in the weld area shall be between 60 and 125 degrees Fahrenheit when the penetrant is applied. Dwell time of six hours shall be allowed after application of the penetrant and developer before interpreting the results. Defects that are found shall be repaired and the test repeated until all defects are eliminated. Colored penetrant shall be removed before fittings are lined.

6.3.9. *Pipe laying conditions:*

The normal minimum cover over top of pipe barrel is to be about 42 inches. Where cover over top is such as to require special treatment, stabilized backfill material is to be used. The grades and elevations shown on the approved plan and profile drawings shall govern.

It is the intent that all ferrous metal be protected upon completion of pipe laying which will require some shop applied coatings and some field applied coatings. Coatings that will not interfere with installation shall be shop applied. Shop application of cement mortar, three-quarter-inch minimum thickness, shall be used for protective coatings. Galvanized wire mesh shall be used to reinforce coatings of specials.

For larger diameter flanges where it is impracticable to use a cement mortar coating, and where directed by the engineer, two heavy coats of Amercoat No. 79 as manufactured by the Amercoat Corporation, or approved equal, may be used. Amercoat No. 79 shall be applied in accordance with the manufacturer's recommendations.

6.3.10. *Delivery:*

6.3.10.1. *Packing:* The pipe shall be prepared for shipment to permit acceptance by the carrier for transportation which will afford maximum protection from normal hazards of transportation and allow pipe to reach project site in an undamaged condition. Pipe damaged in shipment shall not be delivered to the project site unless such damaged pipe is properly repaired and approved by

the engineer.

6.3.10.2. *Marking for identification:* Each length of pipe and each fitting shall have plainly marked on either the bell or spigot end, the class, for which it is designated, the date of manufacture, and the identification number as shown on the shop drawings. All beveled pipe shall be marked with the amount of bevel.

6.3.10.3. *Point of delivery:* It is desired that pipe be hauled direct from pipe plant to the right-of-way and strung along pipe line route, thus avoiding rehandling of pipe and the possibility of damage thereto. Where necessary, pipe may be unloaded at access points along the route, and brought to the trench side by approved methods; however, the contractor shall be responsible for seeing that pipe is undamaged at the time of laying.

6.4. *Miscellaneous:*

6.4.1. *Shop drawings:* Based on plan-profile sheets which have been prepared by the engineer, the pipe manufacturer shall furnish shop drawings of all pipe and fittings which are to be fabricated. Shop drawings shall include a schematic location-profile and a tabulated layout schedule, both of which shall be appropriately referenced to the stationing of the proposed pipe line as shown on the plan-profile sheets. Shop drawings shall be subject to approval of the engineer and fabrication of pipe and fittings shall not be commenced until such drawings have been approved by the engineer. Six copies of approved drawings shall be submitted to the engineer.

6.4.2. *Pipe laying technician:* The services of a pipe laying technician to be present during all pipe laying will not be required as a part of this contract; however, a factory trained technician shall be made available for periodic assistance as required by the owner.

6.4.3. *Laboratory inspection:* The city reserves the right to retain the services of an independent testing laboratory to perform tests and inspections as described in Section 1.8 of American Water Works Association Standard C303-78. If the owner elects to obtain the services of the independent testing laboratory, for assurance of quality control, the city will pay for the services.

6.4.4. *Affidavit of compliance:* The contractor shall furnish to the owner three copies of an affidavit from the pipe manufacturer that the pipe, specials, fittings, etc., including materials, comply with all applicable provisions of the standards and specifications.

Item 7. Installing concrete cylinder pipe.

7.1. *Description:*

Concrete cylinder pipe, fittings, specials and valves are to be installed at locations shown on the plans and specified in these contract documents.

Unless otherwise indicated, pipe in trenches shall be laid to the grade shown or an even grade from point to point for which elevations are furnished. Attention is called to the fact that the engineer will set grades for pipe laying at 100-foot

intervals as specified under "Cover over top of pipe barrel."

All of the requirements of the specifications under section, "Excavation and backfill," govern for the excavation and backfilling of trenches for laying concrete cylinder pipe, fittings and specials.

7.2. Pipe handling:

Pipe, fittings, valves and other accessories shall be hauled to an distributed at the site of the project by the contractor; they shall at all times be handled with care to avoid damage. In loading and unloading, they shall be lifted by hoists or cranes as specified below, or rolled on skidways in such manner as to avoid shock. Under no circumstances shall they be dropped. Pipe handled on skidways must not be skidded or rolled against pipe already on the ground. Pipe shall be placed on the site of the work parallel to the trench alignment and with bell ends facing the direction in which the work will proceed, unless otherwise directed.

Under no circumstances shall the pipe remain on the ditch site for a length of time exceeding 60 days. The time shall be computed from the time the pipe was removed from the final cure at the manufacturing plant to the day it is actually laid in the ditch and backfilled. If in the opinion of the engineer the pipe has been properly protected, the engineer may at his option extend the time stipulated above.

The contractor shall carefully observe the pipe for cracking and checking of the inside lining and should cracking occur in the inside lining the contractor shall take immediate steps to protect the pipe. Any joint of pipe that has shrinkage cracks with a maximum width of 30 mils in the inside lining shall be repaired by the pipe manufacturer by approved methods. If in the opinion of the engineer the pipe is not suitable for repair, then the pipe shall be rejected and removed from the project site.

Proper implements, tools, equipment and facilities shall be provided and used by the contractor for the safe and convenient prosecution of the work. All pipe, fittings, specials, valves, etc., shall be lowered into the trench by means of a side boom, crane and other suitable machines and are not to be rolled or dumped into the trench. The side boom, crane, etc., shall be a sufficient size for handling the pipe, shall lift and lower the pipe at a slow rate of speed, and shall be capable of stopping the lifting operation at any point without producing a shock or otherwise jerking or vibrating the pipe. The hoisting cable pipe clamp shall be connected to the pipe in such a manner to prevent damage to the coating. The method of connection shall be subject to the engineer's approval. Before lowering into the trench, each joint of pipe shall be inspected and any unsound or damaged pipe shall be rejected.

The pipe shall be kept clean during the laying operation and free of all sticks, dirt, and trash, and at the close of each operating day the open end of the pipe shall be effectively sealed against the entrance of all objects and especially water. No pipe shall be laid in water, except in an emergency and then only upon permission of the engineer.

7.3. Pipe jointing, general:

Before laying each joint of pipe, the bell and spigot rings shall be thoroughly cleaned by brushing and wiping. If any damage to the protective coating on the

metal has occurred, it will be required of the contractor to repair such damage before the pipe is laid. The damaged areas shall be thoroughly cleaned and immediately following the cleaning, the metal shall be painted with the same material used originally in the manufacture of the pipe.

Sections of pipe shall be tightly fitted together and care shall be exercised to secure true alignment and grade. Where pipe is being laid the gasket shall be placed on the spigot ring and the spigot end of the pipe shall then be entered into the bell of the adjoining pipe and forced into position. The gasket and the inside surface of the bell shall be lubricated with an approved lubricant (flax soap) which will facilitate the telescoping of the joint. The inside joint recess between ends of the pipe sections shall have a maximum opening of three-quarters-inch and minimum of one-quarter-inch. No blocking up of pipe or joints will be permitted.

7.4. Exterior joint:

The exterior joint shall be made by placing a burlap joint wrapper around the pipe which will be held in place by means of two metal straps. The burlap wrapper shall be seven inches wide and hemmed on each side. The burlap cloth shall be of such length that it will encircle the pipe, leaving enough opening between the ends to allow the mortar to be poured inside the wrapper. The straps shall be of sufficient length to encircle the pipe and securely fasten the wrapper to the joint. The burlap wrappers shall be similar and equal to those manufactured by Marmac Manufacturing Company.

The grout used for pouring the joint shall consist of one part portland cement, (American Society for Testing Materials Specification C-150, Type I) to two parts of clean, fine, sharp (plaster) sand, (conforming to American Society for Testing Materials Specification C-144) and mixed to the consistency of thick cream. The joint shall be filled with this grout from one side in one continuous operation until the grout has flowed entirely around the pipe. During the filling of the joint, it shall be rodded with flexible wire to settle the grout.

7.5. Interior joints 18 inches and over in diameter:

Upon completion of backfilling of the pipe trench, the inside joint recess shall be filled with a stiff cement mortar consisting of one part of cement to two parts of sand by a qualified workman working inside the pipe. Cement shall be Type II or Type III with the modification that the cement shall contain not more than five percent tricalcium aluminate $\text{Ca}_3(\text{Al O}_3)_2$. Cement shall comply with American Society for Testing Materials Specification C-150 and sand shall conform to American Society for Testing Materials Specification C-144. Prior to the placing of mortar, any dirt, or trash which has been collected in the joint shall be cleaned out and the concrete surface of the joint space shall be moistened by spraying or brushing with a wet brush. The stiff mortar shall be rammed or packed into the joint space and extreme care shall be taken to ensure that no voids remain in the joint space.

After the joint has been filled, the surfaces of the joint shall be leveled with the interior surfaces of the pipe by troweling or brushing.

Careful inspection shall be made of every joint to ensure a smooth continuous interior surface. The interior of the pipe shall be thoroughly cleaned and all obstructions removed. Following completion of pipeline progressively or in

sections, including completion of inside joints and inspections, insofar as might be possible or practicable, the line shall be kept filled with water.

7.6. Interior joints 16 inches and less in diameter:

The joint shall be made by buttering the bell of the pipe with a stiff cement mortar consisting of one part of cement to two parts of sand. After the spigot has been pushed into place, the joint shall be smoothly and neatly finished by pulling a rat through the pipe. Cement shall comply with American Society for Testing Materials Specification C-150, Type II or Type III with the modification that the cement shall contain not more than five percent tricalcium aluminate $\text{Ca}_3(\text{AlO}_3)_2$. Sand shall conform to American Society for Testing Materials Specification C-144.

Prior to the placing of mortar, any dirt or trash which has collected in the joint of pipe shall be cleaned out and the concrete surfaces of the joint space shall be moistened by brushing with a wet brush. An amount of mortar slightly in excess of the amount required to fill the joint space shall be applied to the bell.

Careful inspection shall be made of the joints to ensure a smooth continuous interior surface. Occasionally the contractor will be required to remove a completed joint for inspection. The interior of the pipe shall be thoroughly cleaned and all obstructions removed. Following completion of pipe line progressively or in sections, including completion of inside joints and inspection, insofar as might be possible or practicable, the line shall be kept filled with water.

7.7. Protection of exposed metal:

All exposed ferrous metal shall be protected by a minimum of one-inch coating of Portland cement mortar consisting of one part cement and two parts sand. Exposed surfaces such as but not limited to flanges, bolts, caulked joints, threaded outlets, closures, etc., shall be protected in this manner. Where necessary, coating shall be reinforced with galvanized wire mesh.

The surface receiving a cement mortar coating shall be thoroughly cleaned and wetted with water just prior to placing the cement mortar coating. After placing, care shall be taken to prevent cement mortar from drying out too rapidly by covering with damp earth or burlap. Cement mortar coating shall not be applied during freezing weather.

For large diameter flanges where it is impracticable to use a cement mortar coating, and where directed by the engineer, two coats of Amercoat No. 79, as manufactured by the Amercoat Corporation, or approved equal, may be used. The coating shall be applied in accordance with the manufacturer's recommendations.

7.8. Patch:

Excessive patching of lining or coating will not be permitted. Patching of lining or coating will be allowed where area to be repaired does not exceed 100 square inches and has no dimensions greater than 12 inches. In general, there shall not be more than one patch on either the lining or the coating of any one joint of pipe.

Wherever necessary to patch the pipe, patch shall be made with a mortar of one part portland cement and two parts clean, sharp sand; all measurements to be of

weight. Pipe thus patched shall not be installed until the patch has been properly and adequately cured and unless approved for laying by the pipe manufacturer's inspector and by the engineer.

7.9. *Pipe laying technician:* The services of a pipe laying technician to be present during all pipe laying will not be required on this project; however, a factory trained technician shall be made available for periodic assistance as required by the city.

7.10. *Embedment:* Unless otherwise noted herein, all concrete cylinder pipe shall be placed on granular embedment material, below spring line. The embedment material shall be as specified in Item 15 [of this article] and shown on the plans.

Item 8. Asbestos-cement pipe and fittings.

8.1. *General:* Asbestos-cement pipe for water distribution systems, shall conform to American Society for Testing Materials Specification C 296-72, or American Water Works Association Standard C 400, latest revision, except as noted herein. Fittings and special for asbestos-cement pipe shall be cast-iron conforming with ASA Specification A21.10 and/or American Water Works Association Specifications C110 and C100, as applicable; except, fitting ends that are to receive asbestos-cement pipe shall be designed for same type joints as the asbestos-cement pipe joints.

8.2. Asbestos-cement pipe:

Pipe shall be designed to withstand a working pressure of 150 pounds per square inch for the water distribution line. Pipe shall be furnished in standard nominal lengths of 13 feet. Not less than 95 percent of the pipe furnished shall be within plus or minus one inch of the specified nominal length and the remaining five percent shall be not more than six feet six inches less than the nominal length.

Couplings shall be of the standard design of the manufacturer and shall provide tight joints when subjected to 2 1/2 times the working pressure designation of the pipe. One coupling, suitable for the particular size and class of pipe with which it is used, shall be furnished with each length of pipe. Couplings shall each comprise one approved type sleeve and two rubber gaskets. Gaskets shall be of a properly vulcanized rubber compound, uniformly smooth and round and free of porosity, pitting or other imperfections and shall conform to American Society for Testing Materials Specification Designation D 1896, latest revision.

Pipe and couplings shall be stamped so as to show the design working pressure. Pipe and couplings shall be as manufactured by Johns-Manville, Certainteed, or approved equal. Pipe shall be listed as approved by Underwriters' Laboratories, Inc.

8.3. Pipe fittings for asbestos-cement pipe:

It shall be the contractor's responsibility to furnish and install fittings suitable for proper jointing and the purposes intended. Fittings shall be designed for not less than same working pressures as the pipe.

Where gate valves are to be installed in the line, they shall have mechanical joint hubs. Adapters shall be used for mechanical joint valves larger than eight-inch size.

8.4. *Service taps:* The contractor shall furnish and install double-strap service taps as requested by the owner, with brass corporation stop similar and equal to Mueller-H-15000 or H-15025.

8.5. *Pipe handling:*

Asbestos-cement pipe, cast-iron fittings, valves and other accessories shall be hauled to, and distributed at, the site of the project and shall at all times be handled with care to avoid damage. In loading and unloading, the pipe shall be lifted by joists or cranes, as specified below, or rolled on skidways, in such a manner so as to avoid shock. Under no circumstances shall the pipe be dropped. Pipe handled on skidways must not be skidded or rolled against pipe already on the ground. Pipe shall be placed on the site of the work parallel with the trench alignment.

Proper implements, tools, equipment and facilities shall be provided and used by the contractor for the safe and convenient prosecution of the work. All pipe, fittings, valves, etc., shall be lowered into the trench by means of a side boom, crane and other suitable machines and not rolled or dumped into the trench. The side boom, crane, etc., shall be of sufficient size for handling the pipe. The hoisting cable pipe clamp shall be connected to the pipe in such a manner as to prevent damage. The method of connection shall be subject to the city engineer's approval. Before lowering into the trench, each joint of pipe shall be inspected and any unsound or damaged pipe shall be rejected.

The pipe shall be kept clean during the laying operation and free of all sticks, dirt, trash, and at the close of each operating day the open end of the pipe shall be effectively sealed against the entrance of all objects and especially mud and water. No pipe shall be laid in water, or when the trench conditions or the weather is unsuitable for such work, except in an emergency and then only with permission of the engineer.

All pipe shall be laid accurately to establish lines and grades, with valves and fittings at the required location, and with joints properly made. Line and grade stakes will be provided as needed.

8.6. *Pipe laying and jointing:*

Before laying each joint of pipe, the ends shall be thoroughly cleaned by brushing and wiping. The pipe shall be laid on four inches of granular embedment with coupling holes provided. Pipe shall not be supported by couplings. After pipe is installed and joints completed, the granular embedment materials shall be installed upward to not less than six inches above the top of pipe.

Unless otherwise indicated, pipe in trenches shall be laid on an even grade from point to point and as recommended by the pipe manufacturer.

All of the requirements of approved specifications shall govern for the excavation of trenches for laying asbestos-cement pipe, backfilling, etc.

8.7. *Concrete blocking:* Concrete blocking shall be placed at all bevels, tees, crosses, plugs, fire hydrants, etc. The concrete shall have a 28-day compressive strength of not less than 2,000 pounds per square inch and shall be as specified in section for concrete [Item 7 of this article]. The blocking shall be placed to rest on firm undisturbed foundation of the trench bottom. Concrete shall be installed in such a

manner as not to interfere with the repairing of the joint. The bearing area for concrete blocking shall be based on not less than 150 pounds per square inch against the undisturbed vertical face of the trench wall, and not less than that shown on the plans.

Item 9. Gate valves and valve installation.

9.1. General:

Gate valves shall be double disc, parallel seat, internal wedging type with cast-iron body and bronze mountings. Valves three inches to 12 inches in size with a working pressure of 175 pounds per square inch and valves over 12 inches in size with a working pressure of 150 pounds per square inch shall be in strict accordance with the American Water Works Association Standard for "Gate Valves for Water and Other Liquids," C500, latest revision. Gate valves which have a working pressure greater than specified above shall be in accordance with all requirements of American Water Works Association specifications. Flanges for valves shall be drilled to match connecting flanges. All flanges shall conform to the latest standard specification of the American National Standards Institute. Flanges shall be Class 125. Gate valves shall be Mueller No. A-2380 or Kennedy American Water Works Association gate valves. Distribution system gate valves for pipe, other than concrete pressure pipe, shall have mechanical joint ends, unless otherwise approved by the city in writing.

All gate valves shall be nonrising stem and shall turn counter-clockwise to open. Valves shall have a wrench nut for operation unless otherwise specified. Valves 16 feet and larger which are to be installed in a horizontal position, shall have tracks, rollers and scrapers to carry the weight of the gates throughout their entire length of travel. Rollers and scrapers shall be solid bronze and the tracks shall be solid bronze on hard babbitt. All manual operated valves above 16 inches in size and larger shall be provided with gearing, with an extended gear case, with cover plates and with a bypass valve. All gate valves shall be installed in a vertical position unless otherwise shown on the plans.

9.2. Valve boxes for valves:

Cast-iron valve boxes shall be firmly supported and maintained centered and plumb over the wrench nut of the gate valve, with box cover flush with the surface of the ground, or at such other level as may be directed. For each nut-operated gate valve, the contractor shall furnish and install necessary valve boxes. Valve boxes shall be three-piece cast-iron valve boxes of the extension type and shall be similar and equal to Trinity Valley Iron & Steel Company, Pattern No. 4625. Extension shall be provided as required. Valve boxes shall have poured concrete support four inches by two feet by two feet placed at finish surface.

The contractor shall be responsible for adjusting the valve boxes to the proper length to conform to the ground or pavement surface.

9.3. Handling and installing gate valves:

Valves shall be carefully handled and lowered into position by mechanical equipment in such a manner as to prevent damage to any part of the valves. The valve shall be placed in the proper position with stem truly vertical or horizontal as the case may be, and shall be securely held until all connections have been

made. The contractor shall furnish all bolts and gaskets for flanged connections and mechanical joint connections.

After the valve box is in place, backfill materials shall be firmly tamped around the outside so as to hold the box in its proper position. The top of the box shall be adjusted to the proper elevation and securely held in place.

9.4. *Blocking under gate valve:* All gate valves which are buried shall rest on concrete pad. Pad shall extend for the full width of the trench and from back of hub to back of hub (or flange). Care shall be taken to not interfere with the jointing. Concrete shall be of 1,500 pounds per square inch quality.

Item 10. Fire hydrants.

10.1. General:

Fire hydrants shall conform in all respects with American Water Works Association standards for Dry-Barrel Fire Hydrants, American Water Works Association Specification C502-73, except as herein specified. Bury shall be for four feet, measured from bottom of trench to ground line or such other depths as may be required by the profile. Fire hydrants shall be either Mueller Improved A-423 or approved equal complying with city's standards.

Hydrants shall have 5 1/4 inches minimum valve opening on a barrel of approximately seven inches inside diameter. A bronze insert shall be utilized for seat ring. Hydrants shall have bronzed bused weep holes. Hydrants shall be designed for six-inch pipe connection to street main, and shall be equipped with two 2 1/2-inch hose nozzles (national standard thread), and one four-inch 4-484 Mueller steamer nozzle. Hydrants shall have one-inch square, operating nuts, and shall turn counterclockwise to open.

Hydrants shall be of the dry top type, with O-ring packing, and shall have a compression type main valve that closes with pressure.

10.2. Installation:

The hydrants shall be installed at the location directed by the engineer. Unless approved by the city engineer, fire hydrants shall have maximum spacings of 500 feet in residential areas and 300 feet in commercial or mercantile areas. They shall be set truly vertical and securely braced with concrete blocks until self-standing, and shall be surrounded with a minimum of seven cubic feet of washed gravel or stone. Installation details are to be shown on the plans.

The fire hydrants shall be installed with a gate valve between main line and fire hydrant. The main line fitting shall have flanged outlet and the isolating gate valve shall have flange and mechanical joint ends.

Item 11. PVC pipe sewers.

11.1. *General:* Unless otherwise approved by the city in writing, all sewer pipe, four-inch size through 15-inch size, shall be polyvinyl chloride pipe as herein specified. This specification designates requirements for unplasticized polyvinyl chloride (PVC) plastic gravity sewer pipe with integral wall bell and spigot joints for the conveyance of domestic sewage.

11.2. *Materials:* Pipe and fittings shall meet the extra strength requirements of American Society for Testing Materials Specification D3034, SDR 35. (SDR is arrived at by dividing the pipe O.D. by the wall thickness.)

11.3. *Joints:* Joints for the PVC pipe and fittings shall be compression rubber gasket joints. The bell shall consist of an integral wall section with a solid cross section rubber ring factory assembled, securely locked in a place to prevent displacement.

11.4. *Fittings:* Fittings and accessories shall be manufactured and furnished by the pipe supplier or approved equal and have bell and/or spigot configuration identical to that of the pipe.

11.5. *Stiffness:* Minimum pipe stiffness at five percent deflection shall be 46 pounds per square inch for all sizes when calculated in accordance with American Society for Testing Materials Specification D-2412.

11.6. *Dimensions:*

TABLE INSET:

Pipe size (inches)	Outside diameter (inches)	Minimum wall thickness (inches)
4	4.215±0.007	.125
6	6.274±0.009	.180
8	8.400±0.010	.240
10	.500±0.013	.300
12	.500±0.016	.360
15	.300±0.021	.440

11.7. *Receiving, storage and handling:* Care shall be used in unloading and handling to avoid cuts and abrasions to the pipe. Polyvinyl chloride pipe and fittings must be stored to be protected from prolonged heat or direct sunlight. Any protective covering may be used which will not absorb much heat and which will reflect direct rays of the sun. Ventilation should be provided with any type of cover used.

11.8. *Laying pipe:* Pipe shall be laid in accordance with the manufacturer's instructions. This includes making sure that the bell and spigot is clean, and that the spigot is inserted the prescribed amount to allow for expansion and contraction due to temperature change. Joint lubricant shall be used as recommended.

11.9. *Manhole connections:*

Where polyvinyl chloride pipe extends through a rigid manhole wall, it must be recognized that concrete and mortar will not bond to the polyvinyl chloride pipe, and as a result some form of special wall fitting must be provided as leakage around the pipe through the manhole wall will not be acceptable. A ring water stop as an integral part of the wall fitting is one acceptable method.

Where a manhole drop assembly is constructed of polyvinyl chloride pipe, the drop piping shall be encased in concrete outside the manhole.

11.10. *Infiltration test:* The completed sewer line will be tested for leakage by hydrostatic or air test as specified in Item 14 of these specifications.

11.11. *Trench backfill:* Trench and backfill shall comply with the separate section contained in these documents. In general, all polyvinyl chloride sewer pipe shall be

completely encased in Type 1 or Type 2 embedment material, as specified in Item 14, from four inches under the pipe to six inches over the top of the pipe. In such cases where the pipe will cross under a future pavement area, the entire trench shall be backfilled with granular material up to within 12 inches of the natural ground surface.

11.12. *Deflection allowance for installed pipe:* After the pipe has been completely installed and backfilled, a mandrel shall be pulled through the entire line to determine whether the maximum allowable five percent deflection has been exceeded. The diameter of the mandrel shall be five percent less than the inside diameter of the sewer line. In such cases where the mandrel may hang due to excess deflection, the pipe shall be uncovered at this point and the conditions shall be corrected. Correction may be by reworking the embedment and backfill, or by replacing that section of pipe. This portion of the pipe shall again be backfilled, and the mandrel pulled through again, and this process repeated until the pipe is clear of all obstructions.

11.13. *Plugs:* Open ends of pipe shall be effectively plugged any time pipe laying is stopped. Stub-outs from manholes for future connections shall be plugged.

Item 12. Vitrified clay pipe sewers.

12.1. *General:* Unless otherwise approved by the city, all pipe for sewers larger than 15 inches diameter shall be of best quality vitrified clay sewer pipe as hereinafter specified. Pipe shall be tested at the pipe plant by a qualified independent testing laboratory in accordance with American Society for Testing Materials Specification 301. Results of the tests shall be reported to the engineer in writing before shipment of the pipe. Cost of the testing shall be included in the price bid for furnishing and installing the pipe.

12.2. Specifications for vitrified clay pipe and fittings:

All vitrified clay sewer pipe and fittings shall be number one quality, true to straight lines and circles with standard tolerances, and shall in all respects comply with the specifications of the American Society of Testing Materials latest designation C-700, Extra Strength, except as modified herein.

All pipe and specials shall be of best quality vitrified clay and shall be of the hub and spigot pattern. All pipe and specials shall be sound and thoroughly burned throughout, smooth on the inside and free from blisters, lumps or flakes which are greater than one-sixth inch of the thickness of the pipe or one-eighth inch, whichever is the least. The pipe shall be free from fire cracks of any kind extending through the shell. The pipe shall be well formed and straight. The pipe shall have a clear ring when tapped with a hammer. The bells and spigot shall be as near to true circles as can be manufactured in tolerances as permitted by the American Society for Testing Materials.

It shall be the pipe manufacturer's responsibility to furnish pipe that the spigot end of one joint will have a minimum of three-eighths-inch clearance around the pipe and between the bell of another joint when placed together. The pipe shall not be turned more than one-quarter of a round in one direction only to achieve this minimum clearance.

The outside diameter of the barrel may be greater than the maximum figures stated in Table 20 of American Society for Testing Materials specifications, provided the other dimensions are varied accordingly with the specification

tolerances and the revision of the diameter of the pipe shall be carried the entire length of the project.

Barely meeting the requirements of these specifications will not be considered as acceptable. It is intended that these specifications provide a minimum quality which will be acceptable and the supplier will be expected to exceed these requirements. While the American Society for Testing Materials specifications permit the rejection of pipe having fractures, or cracks passing through the barrel or socket, except that a single crack at the spigot end of the pipe not exceeding 75 percent of the depth of the socket or a single fracture in the socket not exceeding three inches around the circumference nor two inches lengthwise may be permitted, it is not the intent of these specifications to permit any appreciable quantity of pipe meeting the herein described permissible fractures. The quantity of fractured pipe to be accepted for this project shall be at the discretion of the owner. As an exception to American Society for Testing Materials specifications, the owner reserves the right to mark with appropriate marking pencil all pipe rejected due to failure to comply with these specifications. The supplier will be expected to load and return this rejected pipe to their stockyards immediately.

12.3. *Classes:* Unless otherwise approved in writing by the owner, all pipe shall be extra strength class.

12.4. *Joints:* The pipe shall have precast compression type joints, such as Dickey Joints, manufactured by W.S. Dickey Clay Manufacturing Company or Delta Steel, manufactured by Can-Tex Industries, Inc., or approved equal. Joints shall be a type approved by the city engineer in writing.

12.5. *Laying clay sewer pipe:*

Upon the required embedment, the pipe shall be laid to the line and grade shown on the plans. The engineer will provide off-set stakes at 100-foot intervals, and will provide the contractor with a cut sheet showing cut from top of hub stake to flow line of pipe. Contractor shall set the pipe to grade and alignment using laser equipment and shall carefully check subgrade of trench, and flow line of pipe for proper grade and alignment. The pipe shall not vary more than one-tenth foot from true line and not more than one-fiftieth from theoretical grade.

Prior to laying, the pipe shall be carefully inspected for compliance with the specifications and pipe which is cracked or broken or that does not fully comply with the specifications shall be rejected, and immediately removed from the site of the work by the contractor.

12.6. *Exfiltration:* All pipe shall be tested for leakage as specified under a separate item in these specifications, using either hydrostatic or pneumatic test.

12.7. *Obstruction test:* After the pipe has been laid and backfilled, a mandrel or ball shall be pulled through the line to ensure there are no obstructions. The diameter size of the mandrel or ball shall be five percent less than the inside diameter of the pipe.

12.8. *Closures:* Two types of end enclosures are required in the construction of the project. One is a temporary closure for use during construction and the other is a permanent closure for sewers which do not terminate in manholes, or where there are stub-outs of manholes.

Item 13. Manholes and cleanouts.

13.1. General:

Manholes shall be constructed at locations shown on the plans or as directed by the engineer. Manholes may be constructed using cast-in-place concrete or precast concrete at the option of the contractor and the approval of the engineer. The contractor's attention is called to the fact that some manhole tops are to be above ground and some manhole tops, installed ahead of land development, may be below the finished ground surface.

As applicable, the details shown on the plans shall apply. All manhole bases, or footings, shall be 3,000 pounds per square inch class concrete.

13.2. Concrete manholes, precast:

Precast, reinforced concrete manholes shall be as fabricated by Gifford-Hill or approved equal. Joints in the precast manhole sections shall be sealed against leakage with preformed plastic material. Ram-Nek, or other approved permanently plastic waterseal. Where the depth of manhole is suitable for precast concrete, the owner will accept this type of construction as equal to the brick manhole.

Precast reinforced concrete shapes shall be furnished for sanitary sewer manhole construction in the form of risers, concentric cones, and grade rings. Precast reinforced concrete manhole sections shall be of the bell and spigot or tongue and groove design meeting the requirements of American Society for Testing Materials Specification C-478 having a wall thickness equal to that of American Society for Testing Materials Specification C-76 wall B. Joints may be preformed O-ring rubber gasket conforming to the requirements of American Society for Testing Materials Specification C-443. Risers shall be in standard lengths of one through six feet in increments of one foot. Concrete used in these manhole sections shall be at least 40 percent of limestone aggregate.

Manhole steps shall be installed by the pipe manufacturer where attention shall be given to a safe structural tie. Vertical center line of steps shall be marked on the outside of each manhole section. Steps shall be noncorrosive material as shown below and on plans.

13.3. Monolithic manholes: Monolithic concrete manholes shall be poured on the job site using specially designed, reusable forms. Manholes shall be poured from 3000# concrete to provide a formed wall thickness of at least six inches. Monolithic manholes shall be substantially watertight when completed. Aggregate shall be at least 40 percent limestone in the concrete.

13.4. Manhole rings and covers:

Manhole rings and covers shall be made of gray iron castings, American Society for Testing Materials Specification A-48, and shall conform to Class No. 30.

The general dimensional requirements for the standard manhole ring and cover shall be as follows:

Inches

Diameter of lid . . . 24
Thickness of lid at edge . . . 1 7/8
Clear opening in frame . . . 22 1/2
Total depth of frame . . . 5 1/4
Depth of lid seat in frame
Outside diameter of frame at bottom . . . 32
Width of frame flange at bottom . . . 4 3/4

The ring and cover shall be equal to Western Iron Works, San Angelo, Stock No. 42, having a weight of 300 pounds or the equivalent pattern produced by Trinity Valley Iron & Steel Company, McKinley Iron Works of Fort Worth, Texas. Lids shall be interchangeable, and adaptable to all other rings of this pattern. The accuracy of the castings shall be such that the lid will have full bearing on the seat ring, and will not rattle under traffic. All castings shall be clean and sound, and free of blow or sand holes and other defects.

13.5. *Manhole steps*: Manhole steps shall be fiberglass or metal coated with approved plastic material. Where steps are installed in precast concrete wall, they shall either be installed at pipe plant using nonshrinking grout or the project site using a nonshrink grout.

13.6. *Manhole drops*: It is intended that a drop manhole piping assemble be installed in all cases where the distance between the incoming pipe and the floor of the manhole is three feet or more. The drop assembly shall be encased in concrete as shown on the plan. All drops are to be installed outside the manhole.

13.7. *Stub-outs at manholes*: Where future connections are expected at manholes, the contractor shall furnish and install stub-out pipe and plug, or cap, as directed by the engineer. Where such stub-outs are to be installed, the engineer will advise the contractor as to details ahead of manhole construction.

13.8. *Cleanouts*: It is intended to provide a cleanout at the dead ends of all sewer lines unless a manhole is provided at that point. Cleanouts shall be constructed in accordance with the details shown on the plans.

13.9. *Five-foot diameter manholes*: Where concrete precast sections are used for five-foot diameter manholes and conical top sections are not available, the owner will consider a straight side without a cone. The top must be properly reinforced with manhole opening at one side. The manhole ring must be set on at least two adjustment rings to allow for future elevation adjustments. If the manhole, five-foot diameter, is in areas that are paved, or subject to being paved, the reinforced top shall be not less than one foot below finish grade and adjustment rings shall be used to bring the top of manhole ring flush with grade.

Item 14. Exfiltration tests.

14.1. *General*: Exfiltration test shall be performed on all sewer pipe by either a hydrostatic or a pneumatic method, as specified.

14.2. *Exfiltration test hydrostatic method*:

All sewer pipe shall be so installed that the completed sewer will have a maximum exfiltration of 150 gallons per inch of internal diameter, per mile of pipe, per 24 hours, where the maximum hydrostatic head at the center line of the pipe does not exceed 25 feet.

In measuring the exfiltration, a temporary test stack to 15 feet above the top of sewer level shall be built in the sewer line just outside the manhole at the upper end of the new line. All open ends (service lines, etc.) shall be plugged and water introduced into the test stack, filling the line and the stack to top level. After water has remained in the line 24 hours, the water level is again brought up to the stack stop elevation. After one hour, the water level is measured from the starting point and the quantity of leakage computed. If necessary, the line shall be repaired and the test rerun until the exfiltration is within the requirements.

The test stack shall be removed upon completion of tests.

Water used in testing may be obtained at the nearest fire hydrant at the contractor's expense.

In lieu of the exfiltration test, the contractor may use or be required to use an air test as specified below.

14.3. Exfiltration test pneumatic method: Air test.

14.3.1. *General:* Where specified, in accordance with the stipulated requirements on the project plans or specifications, air tests shall be made on sanitary sewer systems. Such air tests shall be made by the pressure drop versus time method.

14.3.2. *Requirements:* On sanitary sewer system requiring air tests, the contractor shall furnish all material, equipment and labor. The air gages will be dead weight tested and approved by the engineer. The engineer shall judge the results of the tests. The test shall be performed using the below stated equipment according to stated procedures.

14.3.3. *Equipment:* The equipment used shall meet the following minimum requirements:

- (a) Pneumatic plugs shall have a sealing length equal to or greater than the diameter of the pipe to be inspected.
- (b) Pneumatic plugs shall resist internal test pressures without requiring external bracing or blocking.
- (c) All air used shall pass through a single control panel.
- (d) Three individual hoses shall be used for the following connection:
 - (1) From the control panel to pneumatic plugs for inflation.
 - (2) From the control panel to a sealed line for introducing the low-pressure air.
 - (3) From a sealed line to control panel for continually monitoring the air pressure rise in the sealed line.
- (e) Air compressor of adequate capacity for charging the system.

14.3.4. *Procedures:*

All pneumatic plugs shall be seal-tested before being used in the actual test installation. One length of pipe shall be laid on the ground and sealed at both ends with the pneumatic plugs to be checked. Air shall be introduced into the plugs to 25 pounds per square inch. The sealed pipe shall be pressurized to five pounds per square inch. The plugs shall hold against this pressure without bracing and without movement of the plugs out of the pipe.

After a manhole to manhole reach of pipe has been backfilled and the pneumatic plugs have been checked by the above mentioned procedure, the plugs shall be placed in the line at each manhole and inflated to 25 pounds per square inch. Low pressure air shall be introduced into this sealed line until the internal air pressure reaches four pounds per square inch. Allow at least two minutes for the air temperature to stabilize, adding only the amount of air required to maintain pressure. If the pipe to be tested is submerged in groundwater, insert a pipe probe by boring or jetting into the backfill material adjacent to the center of the pipe, and determine the pressure in the probe when air passes slowly through it. This is back pressure due to groundwater submergence over the end of the probe. All gauge pressure in the test should be increased by this amount. After the stabilization period of 3.5 pounds per square inch of minimum pressure in the pipe) start stopwatch. Determine time in seconds that is required for the internal air pressure to reach 2.5 pounds per square inch. Minimum permissible pressure holding time for runs of single pipe diameter are indicated in the following table.

System tests shall be subject to modification of this table which shall conform to tables and nomograph on file with the engineer.

Should the sanitary sewer system fail air tests, the contractor shall find and repair the leaks and retest. On systems where water tests are applicable for testing manholes, water tests shall be performed on the manhole even though the pipe is air tested.

Cost of all material, equipment, labor, etc., required in testing shall be included in the price bid per foot of pipe in place. _____

Air Test Tables

*Minimum Holding Time in Seconds Required for Pressure
to Drop from 3 1/2 to 2 1/2 Pounds per Square Inch*

Pipe Diameter

	4"	6"	8"	10"	12"	15"	18"	21"	24"	27"	30"	33"	36"	39"
25	4	10	18	28	40	62	89	121	158	200	248	299	356	418
50	9	20	35	55	79	124	178	243	317	401	495	599	713	837
75	13	30	53	83	119	186	267	364	475	601	743	898	1020	1105
100	18	40	70	110	158	248	356	485	634	765	851	935		
125	22	50	88	138	198	309	446	595	680					
150	26	59	105	165	238	371	510							
175	31	69	123	198	277	425								
200	35	79	141	220	317									
225	40	89	168	248	340									
250	44	99	176	275										
275	48	109	194	283										
300	53	119	211											
350	62	139	227											
400	70	158												
450	79	170												
500	88													
550	97													
600	106													
650	113	170	227	283	340	425	510	680	765	851	1020	1105		

TABLE INSET:

Note: To be used when testing one diameter only.

Item 15. Pipe embedment and backfill.

15.1. General:

All water, sanitary sewer and storm drainage pipe will be installed with sand and/or granular embedment. In some cases, a concrete cradle or encasement will be used, as shown on the plans and specified herein. Sand or gravel embedment shall meet the requirements specified herein. Should existing soil conditions dictate different embedment details, alternate types of embedment may be used with approval of the director of public works. Backfill will be with sand meeting the requirements specified herein or native material if the trench is located a minimum of three feet from existing or proposed street paving or in an easement.

15.2. Concrete cradle and/or encasement:

Where shown on the plans or specified or requested by the city, concrete cradle (embedment) or concrete encasement shall be installed. Concrete cradle and encasement shall be 2,000 pounds per square inch concrete meeting requirements of Article III, Item 3. The contractor shall install the concrete cradle and encasement in such a manner as to avoid floating the pipe or moving the pipe out of proper position while obtaining a monolithic concrete section. Additional payment shall be allowed for concrete cradle and/or concrete encasement at the unit price bid with measurement allowable as shown on the

plans. In the event measurement allowable is not shown on the plans, measurement shall be based upon minimum trench width allowed and type section to be used.

15.3. Type 1, sand embedment and backfill:

Sand for embedment or backfill shall be free flowing sand such that the material, when wet, will not form a mud ball or tend to cling together. The material shall follow the gradation set forth below, with a plus or minus two percent allowable tolerance, and shall have a plasticity index for that part passing the Number 40 sieve not greater than two, unless written approval is obtained from the director of public works.

Retained on 3/8 inch sieve . . . 0%

Retained on No. 4 sieve . . . 0--5%

Retained on No. 8 sieve . . . 0--20%

Retained on No. 16 sieve . . . 15--30%

Retained on No. 30 sieve . . . 35--75%

Retained on No. 50 sieve . . . 70--90%

Retained on No. 100 sieve . . . 90--100%

Retained on No. 200 sieve . . . 97--100%

15.4. Type 2, gravel embedment:

Gravel for embedment and/or encasement shall be washed gravel ranging in size from three-quarter-inch diameter to one-quarter-inch diameter meeting the gradation set forth below, with a plus or minus two percent allowable tolerance. The material shall be free from clay and organic material.

Retained on 1 3/4 inch sieve . . . 0%

Retained on 1 1/2 inch sieve . . . 0--5%

Retained on 3/4 inch sieve . . . 30--65%

Retained on 3/8 inch sieve . . . 70--90%

Retained on No. 4 sieve . . . 95--100%

15.5. Approval of material:

The contractor shall submit laboratory reports for gradations, densities and optimum moisture of material he proposes to use for the embedment and backfill to the city staff for approval. The city staff's approval must be obtained before delivering the material to the site.

15.6. Testing of embedment material:

The contractor will make the necessary laboratory tests at his expense to determine the density obtained. The contractor shall schedule his operations and shall use such methods and construction operations so that representative tests of compaction can be obtained. The City of Grapevine's construction inspection section shall be notified 24 hours in advance of all laboratory tests scheduled.

15.7. Payment for embedment:

Unless otherwise specified and allowed for in the proposal items, no separate payment shall be made for embedment. Payment for the pipe furnished and installed shall include embedment as a part of the installation and materials. Where shown on the plans or requested by the engineer, concrete cradle shall be used and shall be paid for separately and in addition to the unit price for water, sanitary sewer and storm drainage pipe.

15.8. Installing embedment and backfill:

After the trench bottom is brought to proper elevation and graded to uniform slope, the contractor shall install the initial or bedding layer of embedment up to a grade slightly higher than that required for the bottom of the pipe and shall scoop out recesses to receive the pipe bells. The pipe shall then be placed on the initial bedding and brought to grade by tamping. Each pipe section shall have uniform bearing on the embedment for the length of the pipe, except immediately at the joint. Where required, adjustment to the pipe grade shall be made by scraping away or filling with embedment material. Wedging or blocking of the pipe will not be permitted. With the pipe set firmly on grade, the bell holes shall be filled and the bedding material extended upward to the proper elevation. Then the sand backfill material, meeting the gradation requirements of Item 15.3., or native material shall be added to complete the pipe zone backfill. The native material shall be free of clods and organic material such as roots or tree limbs. The embedment and backfill shall be placed in lifts not to exceed 12 inches in depth, properly wetted to approximate optimum moisture and mechanically compacted in place to a minimum density of 95 percent of the Standard Proctor Density for sand and gravel and 90 percent of the Standard Proctor Density for native material. Additional lifts shall not be placed until the lift being compacted has reached the density required. This may require some hand work by the contractor. Under no circumstances may the material from trench excavation be returned to the trench within the pavement section and the three-foot strip beyond the pavement edge unless laboratory analysis of the material is performed and written approval is obtained from the director of public works.

(Ord. No. 88-12, § 5, 2-2-88; Ord. No. 89-57, §§ 5--8, 9-5-89)

Item 16. Polyvinyl chloride pipe for water lines.

16.1. Materials:

Polyvinyl chloride pipe shall be Class 150 nonconforming to American Water Works Association Standard C-900. Pipe shall be Blue Brute manufactured by Johns Manville or approved equal. Pipe shall carry the listing of the Underwriters' Laboratories and have approval for use in water distribution systems in Texas.

All polyvinyl chloride pipe shall be encased in embedment material from six inches below pipe barrel to a minimum of six inches above top of pipe barrel.

16.2. Pipe handling:

Pipe unloading shall be done by hand and shall not be dropped, dragged or thrown. Pipe to be left outdoors more than four months must be covered with tarps or opaque polyethylene film; no pipe may be stored outside under direct

sunlight or heat in excess of four months. Pipe shall be stored on a flat surface with full bearing and stacked no more than two feet high on SDR piping. Fittings shall be stored in their shipping containers and out of direct sunlight.

Damaged pipe with excessive deep scratches will be rejected. Out of round pipe which cannot be rounded by hand pressure shall not be used.

16.3. *Pipe laying:*

16.3.1. *Lowering pipe and accessories into trench:*

16.3.1.1. *General:* Proper implements, tools, and facilities satisfactory to the engineer shall be utilized by the contractor for the safe and efficient execution of the work. All pipe, fittings, valves, hydrants and accessories shall be carefully lowered into the trench in such manner as to prevent damage to pipe and fittings. Under no circumstances shall the pipe or accessories be dropped or dumped into the trench.

16.3.1.2. *Inspection of pipe and accessories:* The pipe and accessories shall be inspected for defects prior to lowering into trench. Any defective, damaged or unsound material shall be repaired or replaced as directed by the engineer.

16.3.1.3. *Pipe kept clean:* All foreign matter or dirt shall be removed from the interior of the pipe before lowering into position in the trench. Pipe shall be kept clean by means approved by the engineer during and after laying.

16.3.1.4. *Joining pipe section:* The sealing surface of the pipe, the bell to be joined, and the rubber ring shall be cleaned immediately before assembly, and assembly shall be made as recommended by the manufacturer. When pipe laying is not in progress, the open ends of installed pipe shall be closed to prevent entrance of trench water into the line. Whenever water is excluded from the interior of the pipe, enough backfill shall be placed on the pipe to prevent floating. Any pipe that has floated shall be removed from the trench and the bedding restored. No pipe shall be laid when the trench conditions or the weather are unsuitable for proper installation as determined by the engineer.

16.3.1.5. *Cutting pipe:* The pipe shall be cut in a neat and workmanlike manner without damage to the pipe so as to have a smooth end at right angles to the axis of the pipe.

16.3.2. *Joining polyvinyl chloride to fittings and accessories:*

16.3.2.1. *General:* Polyvinyl chloride pipe shall be manufactured with outside diameters equal to those of cast and ductile iron. Each valve, hydrant, or fitting connected to polyvinyl chloride plastic pipe shall be equipped with a bell or adapter having a profile that permits a seal to be made directly between the pipe end and the bell of the fitting with a rubber ring. The rubber ring shall be supplied by the fitting or accessory manufacturer.

16.3.2.2. *End preparation:* Pipe ends shall be cut square and deburred or rounded in accordance with pipe manufacturer's recommendations.

16.3.2.3. *Push-on joints:* The push-on joint is a single rubber gasket joint. It is assembled by the positioning of a rubber ring gasket in an annular recess in the fitting socket and the forcing of the end of the pipe into the socket. The pipe end compresses the gasket radially to form a positive seal. The gasket and annular recess are designed, sized and shaped so that the gasket is locked in place against displacement. Care should be taken to use the correct rubber ring to match the fitting ring groove profile. Assembly of the ring with the ring groove and entire joint assembly should be in accordance with the manufacturer's recommendations.

16.3.2.4. *Mechanical joint:* The mechanical joint is a bolted joint of the stuffing box type. Each joint shall consist of: (1) a bell provided with an exterior gland having bolt holes or slots and a socket with an annular recess for the sealing gasket and the plain end of the plastic pipe; (2) a sealing gasket; (3) a follower gland with bolt holes matching those in the fitting; and (4) tee bolts and hexagonal nuts.

16.4. *Plugging of dead ends:* Plugs shall be inserted into the bells of all dead-end fittings. Spigot ends of accessories, fittings and plain ends of plastic pipe shall be capped. A reaction or thrust backing shall be provided at all dead ends of pipe that are capped or plugged. Capped or plugged outlets to fittings shall be restrained to the fittings according to the fitting manufacturer's recommendation.

16.5. *Service connections:* Service connections for all pipe diameters and classes shall be made by means of a suitable saddle. Saddles shall be Smith-Blair, Inc., Type 352 with bronze tapped inserts or Mueller H1342, 22, 25, 28, 31, 33, 34 or 35. Corporation stops shall be Mueller H15000.

Item 17. Thrust blocking and miscellaneous use of 1,500 pounds per square inch concrete.

17.1. *General:* At all locations where there are turns in the water distribution piping, concrete thrust blocking shall be used to resist forces which try to separate the line due to internal water pressure. One exception will be the flushing valve installations where the piping will have its own built-in thrust resistance.

17.2. *Construction:* Reference is made to the plan details for general shape and quantities of the thrust blocking. The concrete shall be 2,000 pounds per square inch in compliance with the concrete specifications. All blocking is to bear against undisturbed trench wall. The quantities shown on the plans are believed to be sufficient, and pay quantity will be on that basis. If the contractor should over excavate, then in such event any extra concrete which may result shall be paid for by the contractor.

17.3. *Miscellaneous use of 1,500 pounds per square inch concrete:* While not shown on the plans, there may be some isolated cases where 1,500 pounds per square inch concrete will be required for a small amount of pipe embedment. Also, on the downstream end of headwalls, there may be occasion for a small amount of roughly

finished concrete riprap to control erosion. In such event 1,500 pounds per square inch concrete shall be used at the unit price bid.

Item 18. Sterilization and testing of water lines.

18.1. General:

After the pipe has been laid and backfilled, the newly laid pipe shall be filled with sterilizing solution and after sterilization as specified, the pipe shall be subjected to hydrostatic test.

During the construction operations, workmen shall be required to use utmost care to see that parts of the structures, inside of pipes, fittings, jointing materials, valves, etc., the surface of which come in contact with the owner's water are maintained in a sanitary condition. Contractor shall not insert chlorine in polyvinyl chloride water lines except in the form of chlorine in a water solution. Every effort must be made to keep the inside of the pipe, fittings, and valves free of all foreign matter, sticks, dirt, rocks, etc. As each joint of pipe is being laid, it must be effectively swabbed so that all foreign matter is removed. All fittings and exposed open ends of pipe must be blocked or capped until the line is completed.

After the pipe has been laid and backfilled, and after sterilizing, the newly laid pipe shall be subjected to hydrostatic pressure test by raising the pressure to the specified test pressure of 150 pounds per square inch. At his option, the contractor may install plugs for the purpose of testing pipe.

18.2. Sterilization: Sterilization of the line or any section thereof shall not be commenced until the owner's approval of the method, apparatus, sterilizing agent and the section of the line has been obtained. When the pipeline has been completed, before hydrostatic testing, and before turning over the owner, the line shall be thoroughly sterilized according to the following procedure:

1. Isolate the section to be sterilized so as to completely fill its entire volume capacity with water while adding chlorine solution.
2. Inject chlorine into the section of line being sterilized so that its entire capacity will be filled with water containing chlorine in the amount of 50 parts per million. The sterilizing agent shall be introduced at one end of the section, and released from the opposite end until the sterilizing agent is present at the discharge end in such quantity as to indicate a residual chlorine of 50 parts per million. All valves shall then be closed and the sterilizing solution permitted to remain in the pipeline section for not less than 24 hours.
3. At the end of sterilizing period the sterilizing solution will be discharged from the pipe and replaced with fresh water.
4. A sample of water from the sterilized main shall be taken (not through a fire hydrant) from a suitable tap under the supervision of the owner and submitted to a chemist for analysis. If the test shows a satisfactory quality of water, the line so sterilized may then be hydrostatically tested and placed in service. If the sample shows unsatisfactory quality of water the process of sterilization shall be repeated until satisfactory water is obtained. The contractor shall arrange and pay for the analysis by a

chemist or commercial laboratory.

18.3. *Hydrostatic tests:* The contractor shall test each section of pipe installed by him using the method herein specified. The duration of each pressure test shall be for four hours. Hydrostatic tests shall be performed as herein specified.

18.3.1. *Procedure:*

The contractor shall test the pipeline in sections when all the pipe in the section is at least four days old. The test shall be made against valves as available, or by placing temporary plugs and bulkheads in the pipe, and filling the line slowly with water. Care shall be used to see that all air vents are open during the filling. After the line, or section thereof, has been completely filled, it shall be allowed to stand under distribution system pressure for at least 24 hours to allow the pipe to absorb what water it will and to allow the escape of air from any air pockets. During this period, the bulkheads, valves, manholes and connections shall be examined for leaks. If any are found, these shall be stopped or, in the case of valves in the main line or bulkheads, provision shall be made for measuring the leakage during the test. The water necessary to maintain the test pressure shall be measured through a meter or by other means satisfactory to the engineer. Contractor shall furnish all necessary equipment and make tests at his expense.

Before applying the specified test pressure, all air shall be expelled from the pipe. In the event it is necessary to expel air from high points other than where outlets are provided, the contractor may tap the line for this purpose and afterwards tightly plug the tap. These taps must be made by the use of corporation stop. No extra compensation will be made for these taps.

18.3.2. *Examination under pressure:*

During the last two hours of the test, the entire route of the pipe line shall be inspected to locate any leaks or breaks. Any defective joints, cracked or defective pipe, fittings, or valves discovered in consequence of this pressure test shall be removed and replaced with sound materials and the test shall be repeated until satisfactory results are obtained.

Any and all noticeable leaks shall be repaired regardless of whether the actual leakage is within allowable limits.

18.3.3. *Permissible leakage:* No pipe installation will be accepted until or unless the leakage is less than that specified in American Water Works Association Standard C600-64, Section 13.7, for push-on type pipe.

18.3.4. *Leakage defined:* Leakage is defined as the quantity of water to be supplied into the newly laid pipe, or any valved section of it, necessary to maintain the specified test pressure after the pipe has been filled with water and the air expelled.

18.4. *Filling and testing water lines:*

The contractor's attention is called to the method of filling and testing water lines. Unless otherwise shown all water distribution pipe lines shall be filled by use of

connection to existing city mains. The contractor shall take water at times, and amounts, acceptable to the city. Sterilizing agent shall be added at point of take and the new pipe shall be filled and let stand under pressure until proper time to test for leakage. Before leakage test, valves at connecting ends shall be closed and replacement water for leakage test shall be pumped into the pipe. After hydrostatic test, the sterilizing water used during test shall be drained out.

The contractor shall pay the owner for all water wasted due to leaks or line breaks, based upon city's domestic rate and quantity lost estimated by the engineer.

Item 19. House service connections.

19.1. *General:* House service connections shall be installed at the locations and to the details set forth on the plans. The meter box shall be set 18 inches behind the curb unless directed otherwise and approved by the city.

19.2. *Materials:* Service lines shall be one-inch I.D. Type K copper tubing unless specified otherwise on the approved plans. The corporation stop shall be Mueller No. 15000. The meter stop shall be Mueller H-14255 with lock wing. The bronze bushing shall be Mueller H-15425 with a three-quarter-inch straight meter coupling, Mueller No. H-10890 or angle valve.

19.2a. *Construction:* All trenching, backfilling and pipe laying shall be of first class workmanship and in general compliance with other sections of these specifications. After installation, the corporation stop shall be left in the open position and the meter stop in the closed position. Service lines shall be installed prior to testing the water mains.

19.3. *Service locations:* Unless otherwise designated by the owner, water services shall be located at center of lots to be served. The locations shall be approved by the city.

19.4. *Meter boxes:* Meter boxes for service connections, one-inch size or less, shall be 18 inches diameter corrugated galvanized steel material, 14 inches deep, with cast-iron lid. Boxes for larger meters, and variance from this specification, shall have the city's written approval.

19.5. *Curbs:* Curbs to be marked with "w" stamped in concrete. At time that tap is made, it is to have blue Allen marking tape run from service to top of ground, a two-inch by four-inch stake painted blue is to be driven at the curb behind service.

Item 20. City standards.

20.1. *General:* At intervals the city engineer shall prepare, and city shall adopt, standards that are contained on drawings prepared by the city engineer. Planners or engineers, shall inquire ahead of plan preparation as to such standards being available and shall use same in construction plans. Variation shall have written approval of the city's engineer.

20.2. *Availability of city standards:* Copies of city standard detail drawings may be obtained from city engineer's office at same cost as set up by reproduction firms.

Item 21. Construction standards for installation of irrigation systems in

subdivision rights-of-way.

Developers of subdivisions shall be required to install irrigation systems in rights-of-way which satisfy the following criteria:

- 21.1. All sprinkler heads and related equipment must be Toro automatic electric or a city-approved equal.
- 21.2. The double check valve must be FEBCO, or a city-approved equal, and placed in a vault box approved by the city.
- 21.3. The plans will be checked as to locations of the water meter, double check valve, electrical connections, control box and line locations.
- 21.4. Mueller gate valves, or a city-approved equal, must be used.
- 21.5. All PVC pipe shall be Class 200 for lines and Schedule 40 for fittings.
- 21.6. Any materials and/or parts not specified shall meet the requirements of the Grapevine Plumbing Code.

All persons intending to install irrigation systems must be licensed irrigators or licensed installers as regulated by V.T.C.A., Water Code § 34.001 et seq.

All approvals under this Item 21 shall be made by the director of parks and recreation or his or her duly authorized designee.

(Ord. No. 87-67, § 2, 10-6-87)

GRAPHIC LINK: gate valve and valve box